THIS ISSUE IS IN TWO PARTS—PART I

DECEMBER 1960

# Heating Piping & Air Conditioning

. . . for Consulting Engineers • Mechanical (Heating, Piping, and Air Conditioning) Contractors • Engineers with Plants and Big Buildings

**ENGINEERING DATA FILE**

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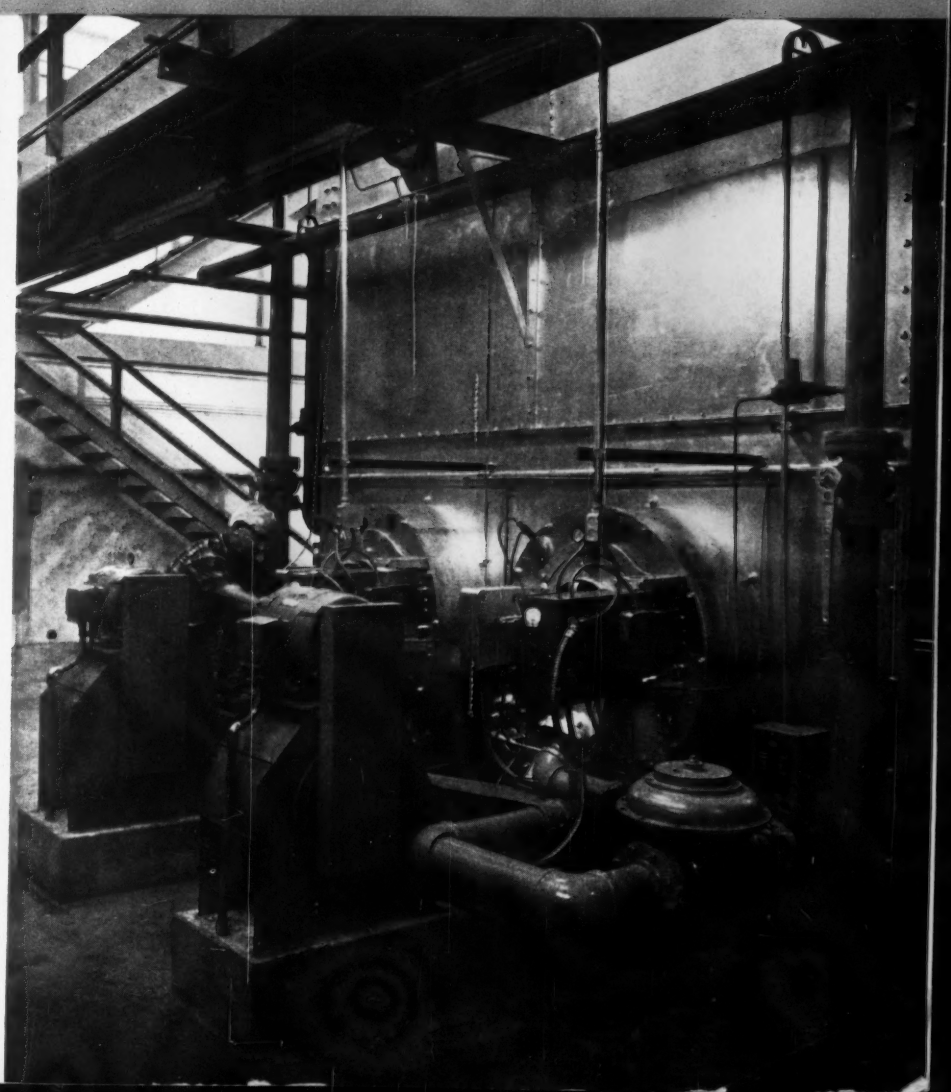

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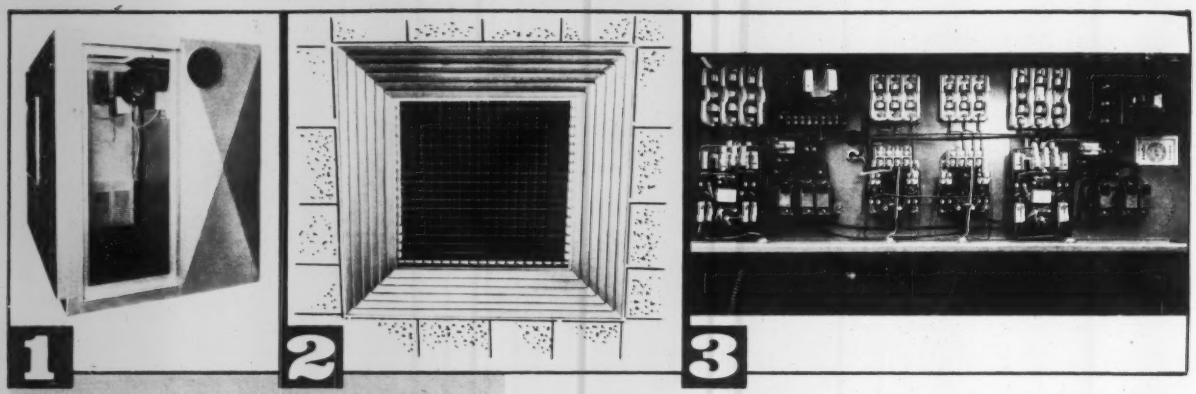


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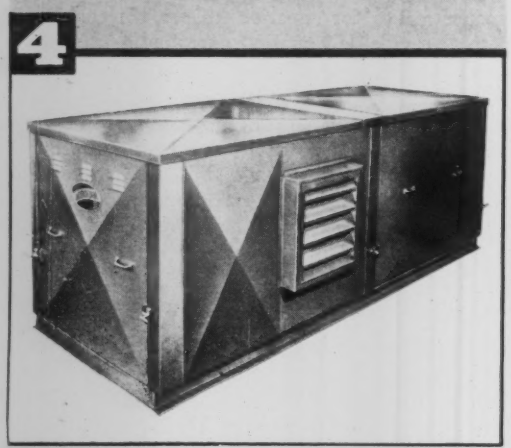


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FOR CONSULTING ENGINEERS, MECHANICAL (HEATING, PIPING, AND AIR CONDITIONING) CONTRACTORS, ENGINEERS WITH PLANTS AND BIG BUILDINGS

VOL. 32, NO. 12 DECEMBER 1960


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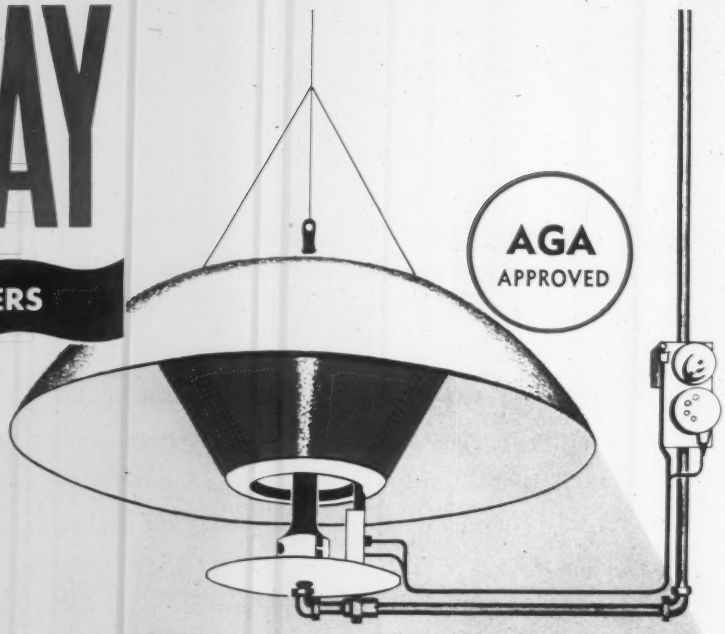


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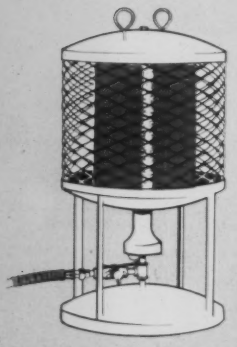

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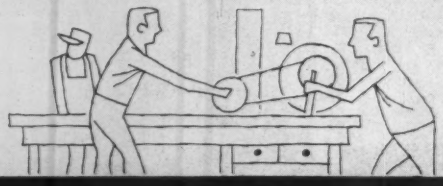

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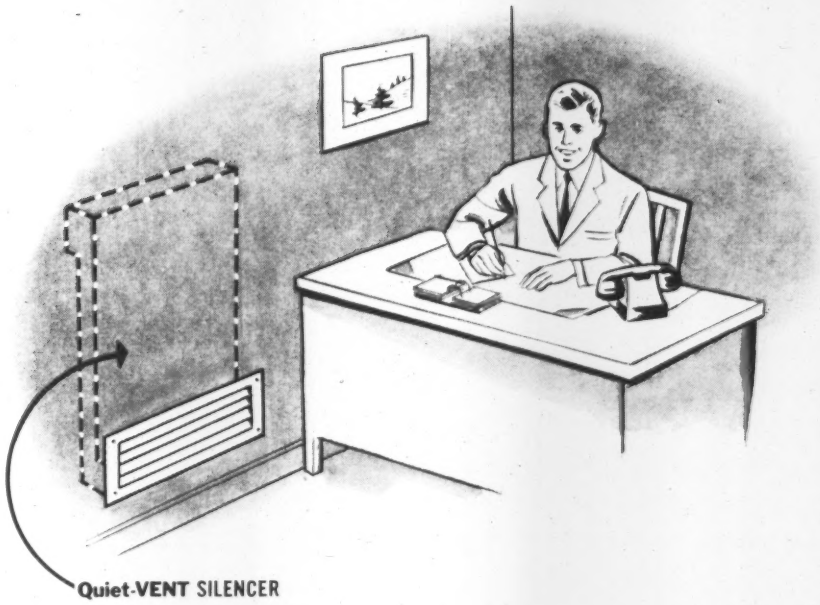


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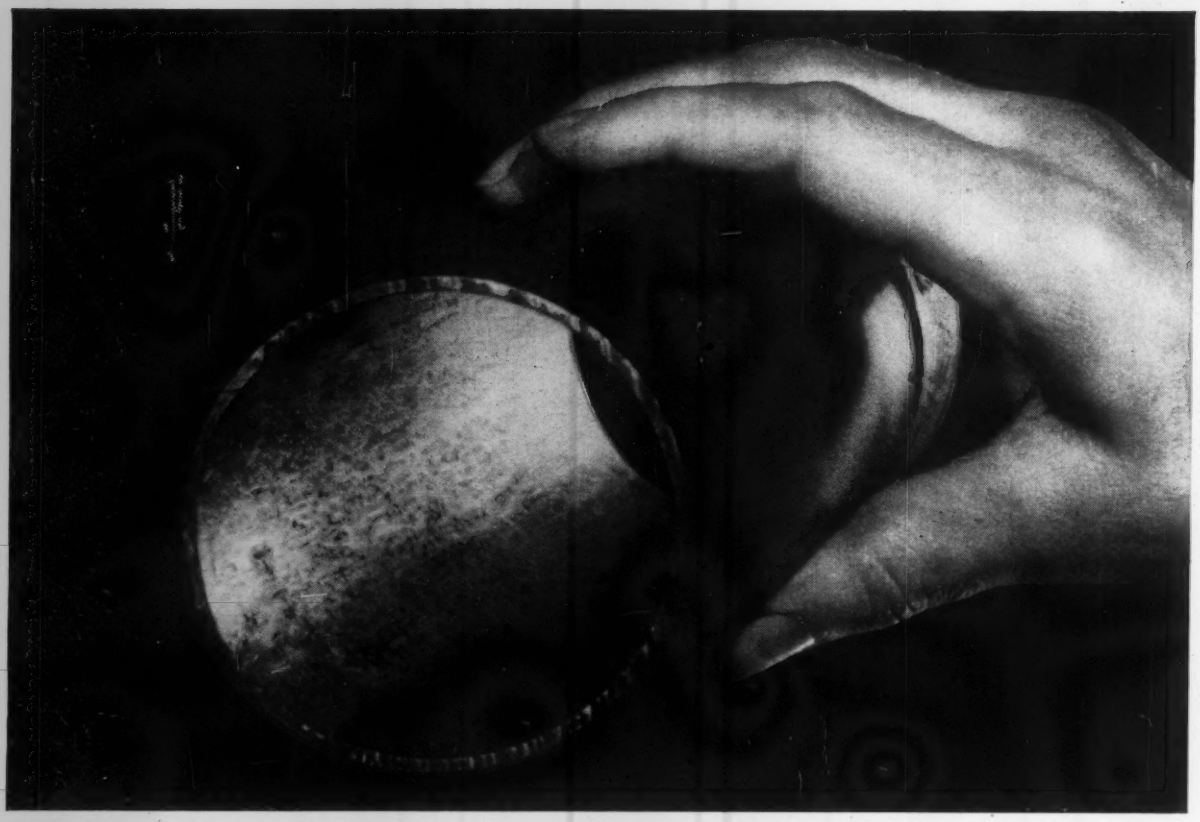
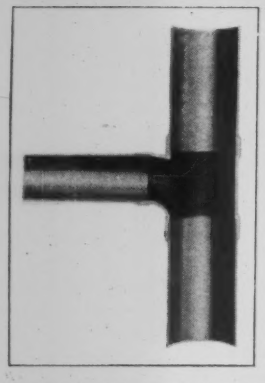


Unretouched photo of 3" dia. copper tube removed after 13 years' service in a soil line.



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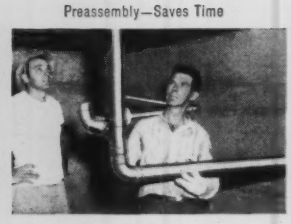

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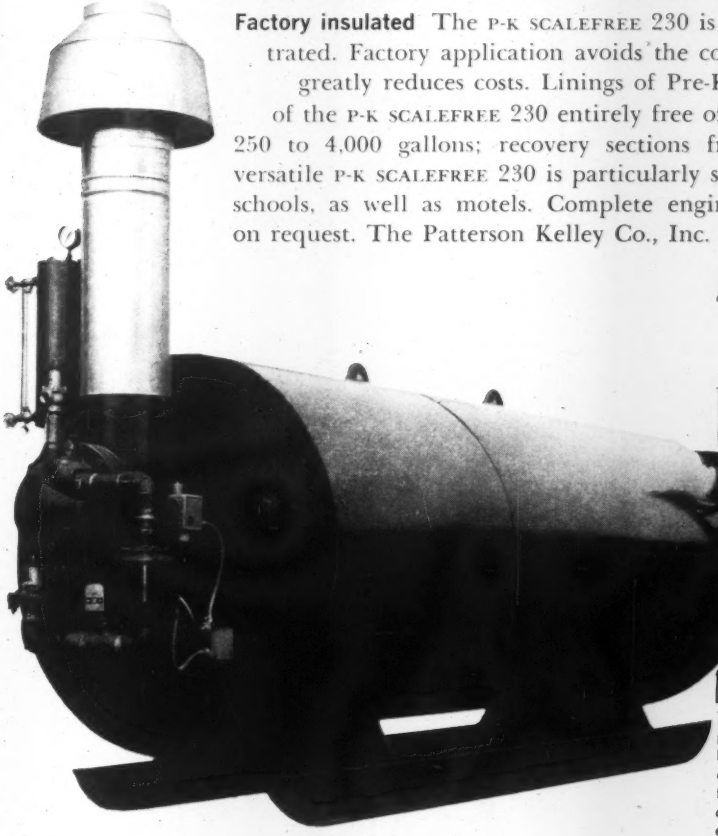
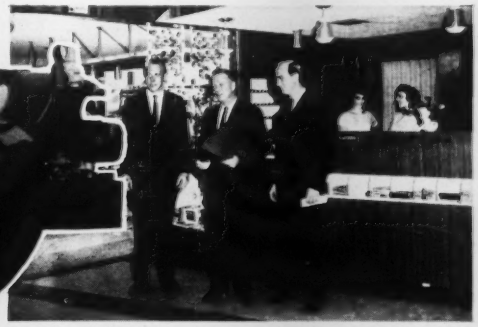


Heating-Air Conditioning Contractor, Kingston Electric Co., Kingston, Pa.



The Carousel Motel and Restaurant, with a capacity of 600 persons, recently opened at Wilkes-Barre, Pa., is owned by William Heck, William Heck, Jr., and Thomas Heck. They chose the P-K SCALEFREE 230 because it offered ideal performance and economy features for a service business such as theirs. The Pre-Krete lined unit has a storage capacity of 500 gallons, and a recovery rate of 325 gallons per hour from 40°F to 140°F.

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# LETTER FROM THE EDITOR

December 1960

Dear Reader:

Selecting a double-loop, high-pressure and low-pressure steam system for the new Bethel Park, Pa. senior high school campus buildings was decided after many factors were weighed. Expansion for three future buildings had to be planned in the design of the system and in determining the capacity of the gas-fired central boiler plant. Elwood S. Tower, consulting engineer for this project, explains in his article on page 103 the reasoning behind the decisions and what was done. The economy of operating this heating system during the 1959-60 heating season is also reported. The design of this heating and ventilating system for this campus-type school achieves a balance between initial equipment and installation costs, fuel economy, control flexibility, system expandability, multiple uses for the steam generated, and compliance with state code requirements for classroom ventilation.

The new Pan Am building in New York City will be served by a big air conditioning system with many interesting features that were included in order to keep pace with the modern design of this 49-story octagonal tower. Lewis Smith explains in his article on page 108 how the exterior louvers for the perimeter induction units and for the separate interior system were integrated into the building's facade. In this way, the architectural harmony has been preserved. Primary air risers are in special shafts within the core of the building, while the water piping for the system adjoins the structural columns. I'm sure you will agree with Mr. Smith in his point that this new building will stand as a continuing testimonial to the fact that imaginative mechanical design can meet the most stringent requirements of modern architectural planning.

How the refrigerant piping system was designed and installed in the slab of the foundation for the movable 225 ton radar antenna for the ballistic missile early warning system in the Arctic is explained by James A. Fife in his article on page 112. Many interesting problems had to be solved as this project was being planned. Mr. Fife discusses what was done and why it was done in this article. This project demanded new methods for combating the permafrost problem, and he tells how these were developed through calculation and careful analysis. He also explains how this system has satisfied the requirements and how the system was tested.

Since our first report of air curtain entrances about four years ago in these pages, many have been installed and they are increasing in popularity now. An interesting application of a very large air curtain entrance and how it was designed is explained by Norbert Zehnder in his article on page 119. Because of the extreme width and height of the entrance to the Pan American Airways terminal building at Idlewild airport in New York, special problems were solved through wind tunnel tests to determine the size and placement of wind screens to assure reliable and effective service. Six axial flow fans deliver 600,000 cfm through silencer units and into a large glass supply plenum before being discharged into the air curtain entrance. A special automatic control system which adjusts the angle of delivery to meet different conditions was developed for this application.

Designing the snow melting system in which oil is to be used as the heating medium requires very careful consideration of many factors. R. B. Purdy explains what needs to be done to achieve the desired results in his article on page 123. The system should be designed especially for the oil to be used. Mr. Purdy also discusses the various methods used to heat the oil properly and the type of pumps that should be used. Good piping installation practices are most necessary also after the system has been properly designed.

LETTER FROM THE EDITOR (continued) --

Early and complete planning in the design of the air conditioning system for the new Diamond Department Store in Phoenix combines good operation with ample provision for easy expansion at some future date. R. R. Kirkwood explains in his article on page 126 what means were employed to insure that a growing business would be provided with a year 'round air conditioning system to match its needs along the way.

How the problems can be solved in air conditioning modern commercial aircraft is explained by Victor Chun on pages 129 to 132. Mr. Chun discusses the air cycle and vapor cycle systems which are used to air condition the DC-7C and the DC-8 jet aircraft and presents an analysis of the problems encountered and how these systems meet them. He also has included some comments on the questions posed by the advent of higher, faster flying jet planes which will be of interest to you, I am sure.

To find the proper air flow rate for industrial solvent dilution, I suggest that you use the Data Sheet on page 133. Clyde F. Metzler has prepared this for publication in this issue, and he has included two examples to aid in its use.

The first article in a series on the the subject of electronic controls and how they work is on page 135. The author, John Schwartz, explains the fundamentals of the functions of these controls, and he has included several easily understood illustrations to aid in presenting the basic principles. This article will aid the heating, piping, and air conditioning engineer and contractor in knowing what these electronic controls can do and what can be expected of them.

More interpretations of the Code for Pressure Piping are given on pages 141 and 142. These cases are concerned with nuclear piping applications and elaborate on the cases presented previously in the April 1960 issue.

How the flooded evaporator may be used for both air cooling and liquid chilling is discussed in detail by Professor W. F. Stoecker in the HPAC Engineering Data File on pages 143 through 160. Flooded evaporators are most popular at present in process cooling applications, but find considerable use in chilling water for air conditioning. He explains the advantages and disadvantages of the flooded system, how to obtain liquid-vapor separation, how to design the surge drum when needed, how to separate oil and refrigerant mixtures, and how to control the flooded evaporator. This information will be of interest to the designer and operating engineer as well as the mechanical contractor because it fully explains why these systems function as they do.

Two more answers to the question, "How Can We Protect Boilers' Internal Metal Surfaces?" are given on pages 96 and 98. These answers contributed by Robert S. Fredericks and E. C. Hach together with the answer by John W. Turner last month include some practical tips worth your consideration.

Don't miss the You'll Want to Know news items on pages 39 to 44 and the many other editorial items of interest in the Equipment Developments section and in the other pages too. The Trade Literature Supplement, Part 2 of this issue, also offers many bulletins and circulars containing worthwhile information for your reference.

Bob Roose

Editor, HEATING, PIPING & AIR CONDITIONING

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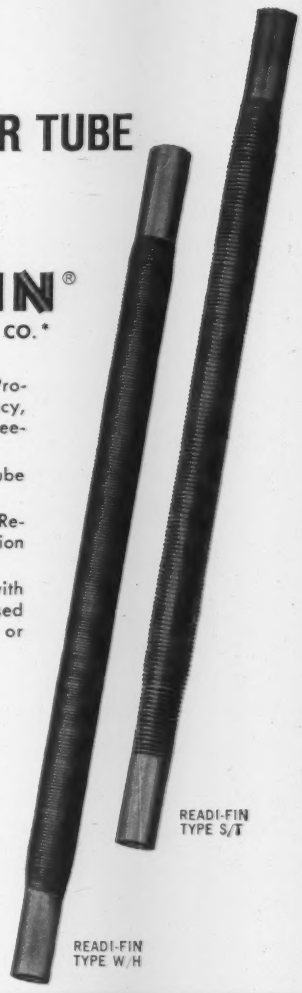


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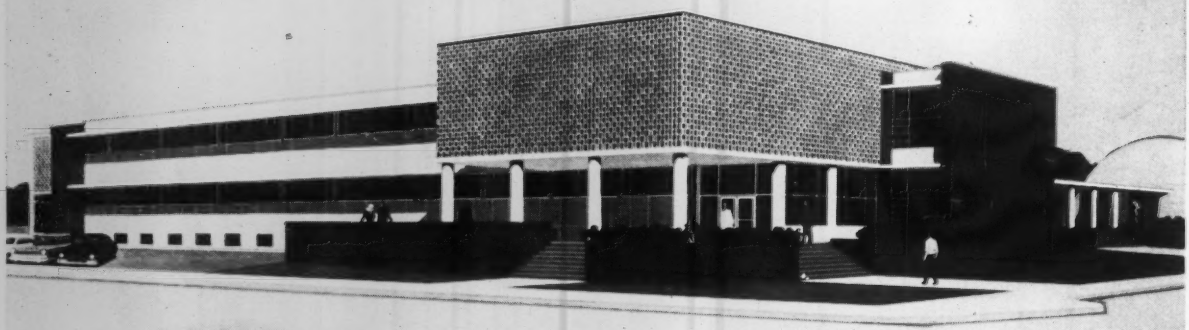
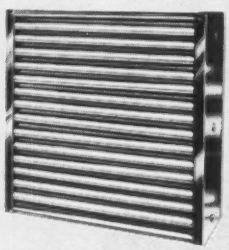
**DALLAS, TEXAS,** 9000 Sovereign Row • **HOUSTON, TEXAS,** 1121 Rothwell St.
**LOS ANGELES, CALIF.,** 120 No. Santa Fe Ave. • **OAKLAND, CALIF.,** 410 Hegenberger Rd.

in the Chemistry-Geology Building,
San Antonio College, San Antonio, Texas



Phelps & Dewees & Simmons, Architects
Gerard M. Baker, Consulting Engineer
Jud Plumbing & Heating Co., Inc., Contractors

# STALE AIR is RECOVERED, RENEWED, READIED for economic RE-USE by DOREX



#52C CELL

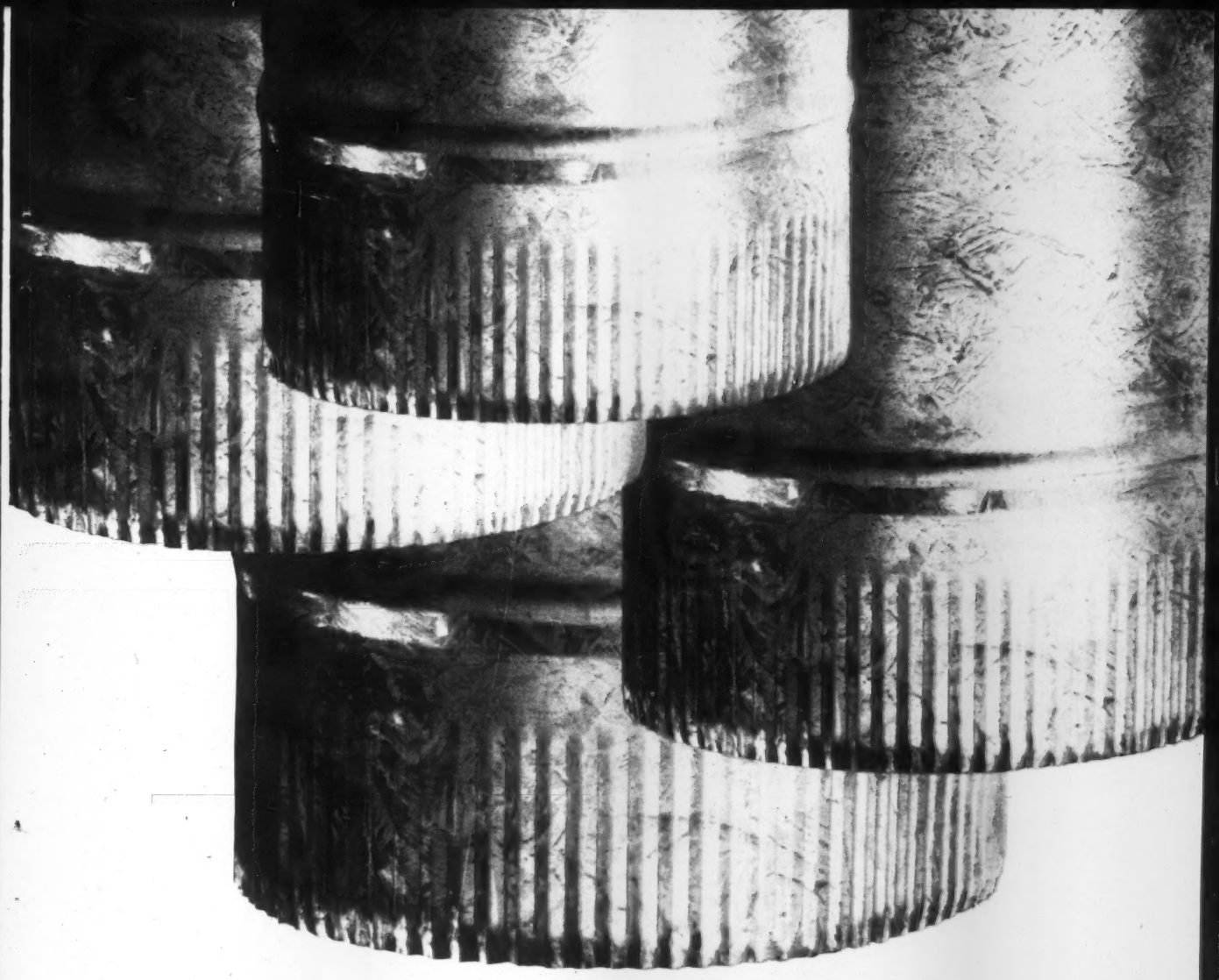
Permanent economy in air conditioning system operation is a key concern of architects and engineers alike in their conception and design of modern buildings.
. . . which is precisely why Dorex Air Recovery equipment is a vital part of the air conditioning systems of so many new structures, large and small. It has been proved that air conditioning costs can be cut by 78% annually if a system uses Dorex to recover stale, already conditioned air rather than use 100% outside air.
Here in the new Chemistry-Geology building, San Antonio College, thirty activated carbon Dorex #52 C Cells, designed into the supply air system in the building's fan room, recover the fume-laden, already used air, convert it to original freshness, and bring about maximum economy in the air conditioning process. The thirty cells have a combined air handling capacity of 30,425 cfm.

For more information, request—on your letterhead, please—copies of Bulletin 108A and the textbook, "Air Conservation Engineering" Contact the representative near you or write to Connor direct.

CONNOR ENGINEERING CORPORATION
DANBURY • CONNECTICUT

CONNOR ENGINEERING CORPORATION
dorex® air recovery

*. . . the most experienced professionals in air recovery and purification.*



The more crimping you have to do, the more satisfied you will be with Weirkote Zinc-Coated Steel. There's no peeling, no chipping, no flaking. Work it to the limits of the steel base itself and the zinc coating remains intact assuring you of the complete corrosion protection that only zinc can give. Weirkote is made that way—to retain its protective zinc coating no matter how tough the forming and bending operations. A Weirton representative will gladly supply full information on Weirkote—another fine product of the Weirton Steel Company, Weirton, West Virginia.

Galvanized Steel

*Look for the STEELMARK on the products you buy; place it on the products you sell.*

**WEIRTON STEEL**
*Weirton, West Virginia*

WEIRTON STEEL COMPANY

*Weirton Steel is a division of* **NATIONAL STEEL CORPORATION**

*Weirkote will also be available in 1961 from National's Midwest Steel Division, Portage, Indiana.*

# the skating is fine in Atlantic City

## . . . on rinks built with steel pipe

"Ice skating on our private rink" is a sign now frequently seen next to "Tourist Accommodations" in Atlantic City, N. J. The four establishments shown here have found this added attraction a great help in extending the tourist season throughout all twelve months of the year.

Attractive, too, to the builder and contractor alike, is the promise of long rink life given to each of these rinks by Bethlehem steel pipe. And the low cost of steel pipe is another big feature—it's considerably less expensive than any other ferrous piping material. What's more, steel pipe is available in double-random lengths—and can be fabricated *cold!*

Practical advantages like these make steel pipe the first choice for ice rink installations. Your pipe distributor will be glad to talk it over with you. Or call the nearest Bethlehem sales office.

Steel

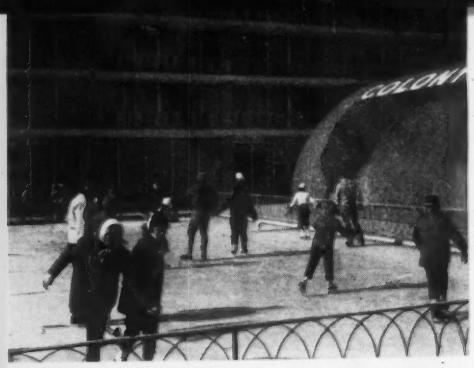
*for Strength . . . Economy . . . Versatility*

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

*Export Sales:* Bethlehem Steel Export Corporation

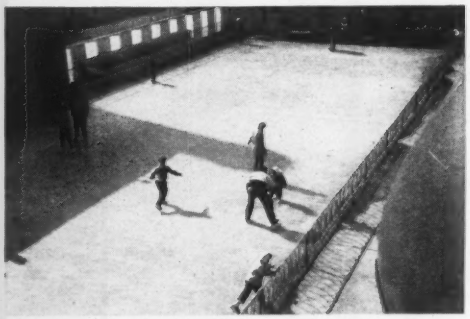
BETHLEHEM STEEL

**BETHLEHEM STEEL**



**Colony Motel**

*Ice rink:* 35 x 70 ft
*Architects:* A. L. & Stanford G. Brooks
*Engineer:* Jack P. Hartmann
*Contractors:* Benjamin E. Labov & Sons
*Pipe Jobber:* Seashore Supply Co.



**Empress Motel**

*Ice rink:* 40 x 100 ft
*Architect:* Rodney C. Williams
*Engineers:* S. B. & B. H. Strouse
*Contractors:* Benjamin E. Labov & Sons
*Pipe Jobber:* Seashore Supply Co.

**Chelsea Hotel**

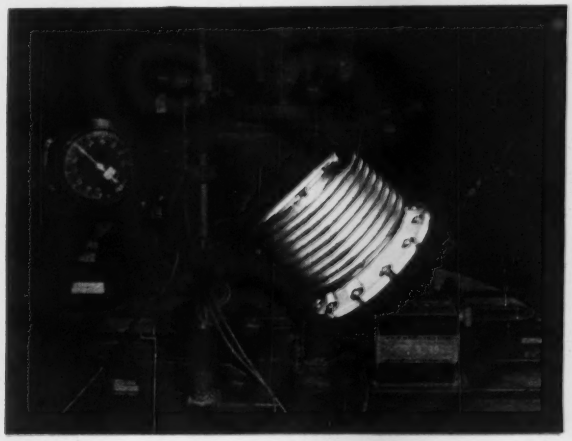
*Ice rink:* 35 x 70 ft
*Piping Engineers and Contractors:* Benjamin E. Labov & Sons
*Pipe Jobber:* Seashore Supply Co.

**President Hotel and Motel**

*Ice rink:* 45 x 90 ft
*Architect:* Rodney C. Williams
*Engineers:* S. B. & B. H. Strouse
*Contractor:* Wm. J. Crane Company
*Pipe Jobber:* Seashore Supply Co.

# 4 WAYS to get maximum reliability in expansion joints

**1** Insist that the corrugated bellows be hydraulically formed. The reason is simple. Whenever bellows are formed by circumferential welding . . . whether by edge, seam or fillet welding . . they will always be subject to premature failure because of stress concentrations at the welds.



**2** Be sure the manufacturer maintains a continuous and comprehensive program of endurance testing. This is basic, because of the many variables that affect expansion joint life. Accurate determination of expansion joint life expectancy can only be determined by cycling to destruction.

**3** Demand proof that the manufacturer can produce longitudinal welds in the corrugated bellows having the same strength, physical properties and thickness as the parent metal . . . without grinding. A weld that is hard to find is a ground weld. Variations in weld thickness set up points of stress concentration . . . opening the way for premature failure.

**4** Check the ability of the manufacturer to supply a team of *competent* design and application specialists to work with your engineers. Check their specific experience in handling critical, complex applications in your field . . . complete to the record of successes or failures behind them, and details of how this experience will be brought to bear on your problem.

At Zallea, none of the many factors affecting expansion joint reliability are left to guesswork . . . including the four vital ones above.

This is reflected in these facts. Zallea material specifications are the most exacting in the industry. Zallea expansion joints are hydraulically formed. Zallea advanced welding techniques insure welds having the same thickness, strength and physical properties as the parent metal. Zallea has done more cyclic testing to destruction than all government agencies and industrial firms combined. Zallea has produced more expansion joints than any other manufacturer . . . offers more application engineering experience.

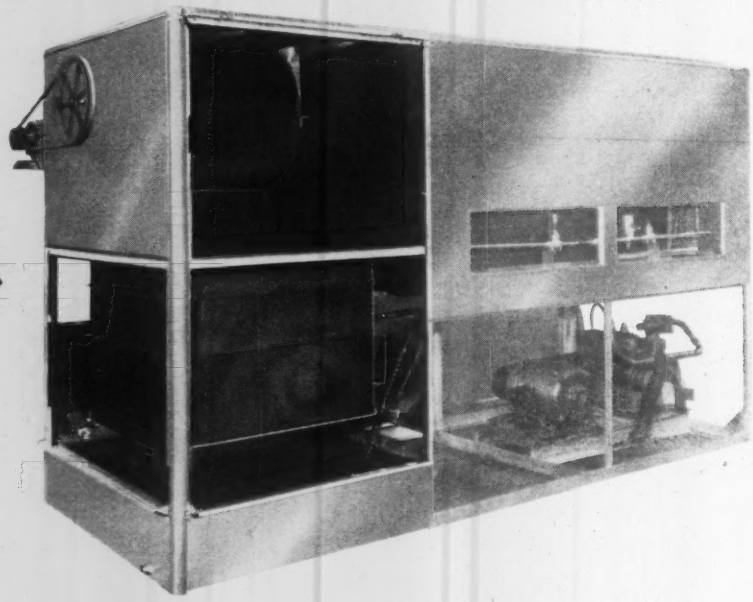
For all the facts, write for Catalog 56. Zallea Brothers, Taylor and Locust Streets, Wilmington 99, Delaware.

*Zallea for maximum reliability*

**ZALLEA BROTHERS, Wilmington 99, Delaware • World's largest manufacturer of expansion joints**

THE ULTIMATE
IN QUALITY
AND PERFORMANCE

# SPECIFY PROLONGED LIFE!



*Governair's*

# COPPER FITTED

**EVAPORATIVE CONDENSER**

*FEATURES:*

ALL COPPER AND BRASS water pan, float valve, condenser coil, spray tree, eliminators, blower scrolls. Standard galvanized blower wheels and stainless steel shaft.

WRITE FOR COMPLETE INFORMATION

You have a definite feeling of confidence when you specify Governair's COOPER-FITTED evaporative condenser with its many fine features.

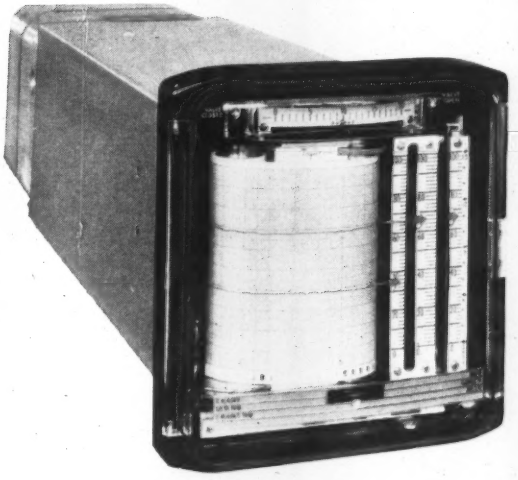
ALL spray water is contained within a COPPER WATER JACKET. This exclusive DOUBLE WALL CONSTRUCTION assures product longevity and lower maintenance. In fact, throughout the entire unit, you find QUALITY . . . with no worry about faulty galvanizing or temporary corrosion protection.

You also have an extremely WIDE SELECTION, as this evaporative condenser is supplied for REMOTE installation or as an integral part of Governair Corporation's self-contained PACKAGED equipment . . . Conventional; Multi-Zone (as pictured); and Water Chillers.

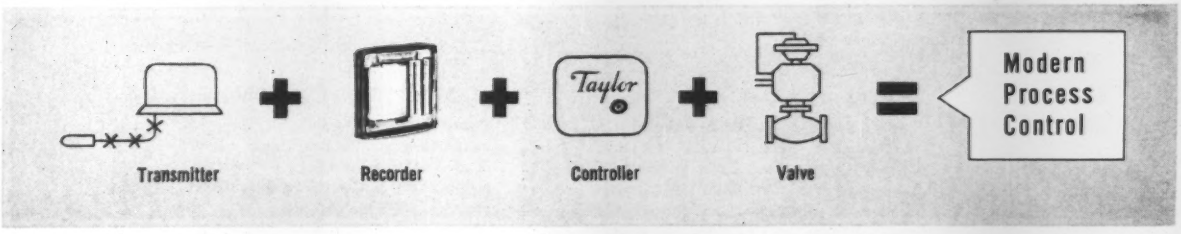
**GOVERNAIR**

4840 N. SEWELL • OKLAHOMA CITY

# *Taylor* TRANSCOPE® RECORDER



*. . . the finest miniature recorder ever produced for the Air-conditioning field*




## No other recorder, regardless of size, puts so many features in so little panel space

The Taylor Transcope Recorder (90J) is now generally recognized as the most modern, most convenient and most accurate instrument for recording process variables at a central point.

**Servo-Operated Pens** have 150 times greater power, assuring unprecedented accuracy of records.

**Front-of-Panel Control Settings** let you make adjustments easier, quicker and better . . . *from the front of panel* . . . while recording!

**Stays on Automatic Control** while the plug-in recorder slide is removed for inspection, yet providing continuous fully automatic control.

**Complete Indicating Control Station** while recorder is removed. Horizontal gage at top of recorder will show either process variable or air output to valve, as desired.

**Receives Three Variables** to be recorded or indicated; has a Set Point Transmitter; Process Alarms with Memory Pointers; an Automatic-to-Manual switching lever; a cascade of Process-output Indicator, and many other features . . . all in a compact case.

*See your Taylor Field Engineer, or write for* **Catalog 98286.**
*Taylor Instrument Companies, Rochester 1, New York, or Toronto, Ontario.*

*Taylor Instruments* **MEAN ACCURACY FIRST**

# HUSSEY COPPER

## The Temperature-Sensitive Metal for Air Conditioning

### THERMAL CONDUCTIVITY

Copper and the low-zinc brasses offer outstanding heat transfer rates. Hussey Copper and brass products have been recognized thermal material for 111 years.

### CORROSION RESISTANCE

There's a Hussey copper alloy to meet most every corrosion problem; chemical, heat exchanger, processing equipment, refrigeration apparatus, etc.

### STRENGTH

High-zinc brasses, nickel silvers, silicon bronzes and phosphor bronzes can provide tensile strength of up to 105,000 psi.

### FORMING FACILITY

Hussey Copper has excellent hot and cold workability characteristics. Whether you bend, stamp, spin or machine, there's a Hussey copper to do your job.

### JOINING

Hussey Copper and copper alloys lend themselves readily to soldering, brazing or welding by a variety of methods.

### BEAUTY FINISH

Hussey copper is an attractive decorative material itself. It takes plating, anodizing, porcelain enamel and many kinds of finishes economically.

COPPER & BRASS WAREHOUSE ASSOCIATION, INC.

HUSSEY

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

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PHILADELPHIA (30).....1632 Fairmount Avenue
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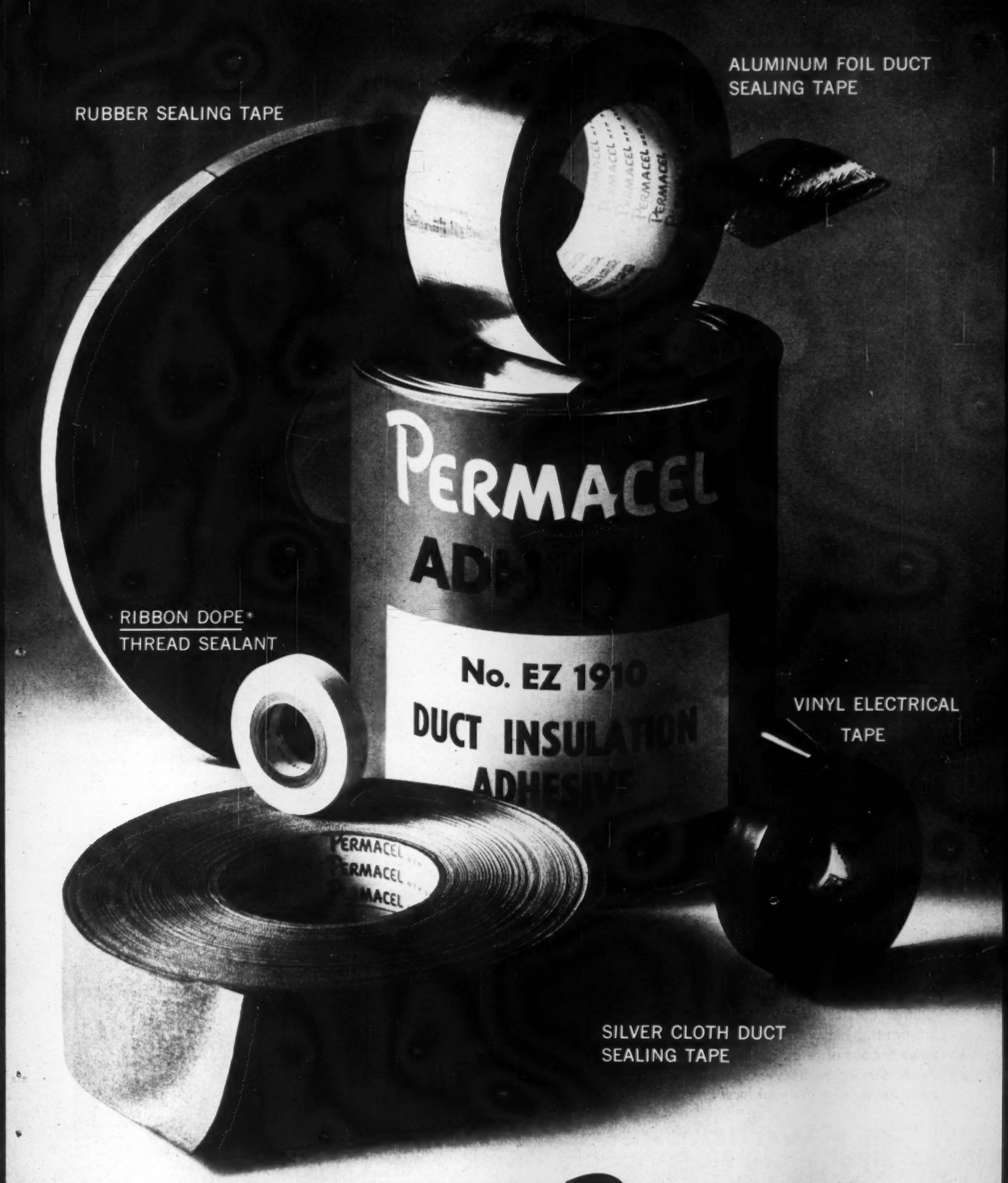
## C. G. HUSSEY & CO.

*(Division of Copper Range Co.)*

**Rolling Mills and General Offices**

**PITTSBURGH 19, PA.**

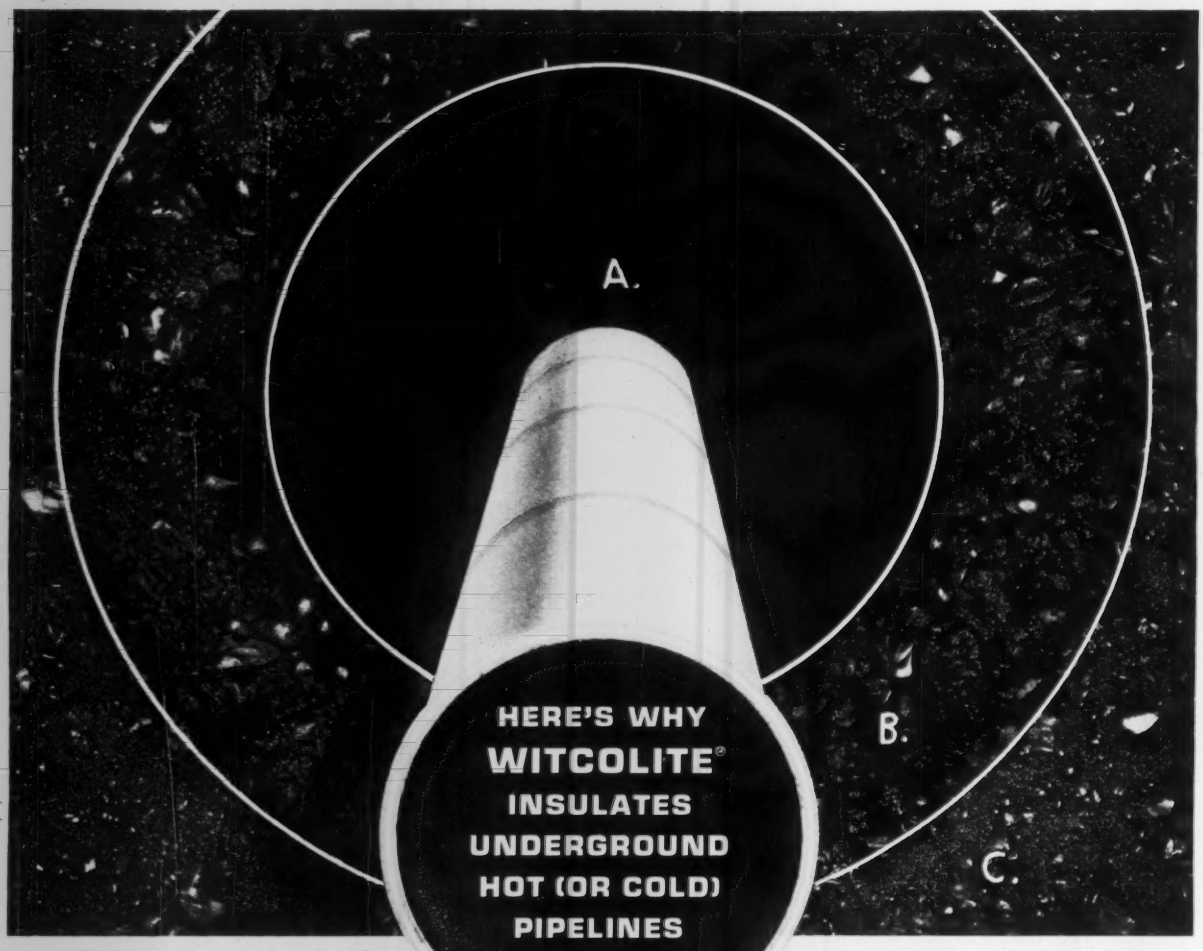
**SEVEN FULLY STOCKED WAREHOUSES**




Whatever the job . . . **PERMACEL®**

*Trademark

NEW BRUNSWICK, NEW JERSEY • TAPES • ELECTRICAL INSULATING MATERIALS • ADHESIVES

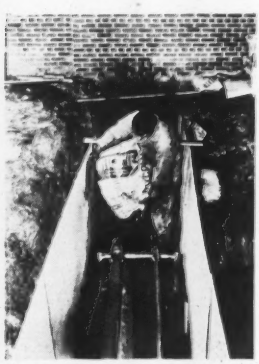



Diagrammatic cross section of pipeline insulated with Witcolite.®

Witcolite is a granulated, resilient adhesive material which is easily installed. After curing, three zones of insulation are formed:
A) **cured zone**—insulating and anticorrosive area locked around pipe. B) **sintered zone**—air-pocketed insulating area...moisture barrier. C) **granular zone**—loose particles providing maximum thermal insulation.

## WITCOLITE OFFERS ALL THESE ADVANTAGES

**3 LABORATORY-CONTROLLED GRADES** of granulated particle size assure perfect high thermal insulation of underground hot pipes...even with pipes alternately conveying hot and cold liquids. **HIGH THERMAL INSULATION** is the result of Witcolite's three zone protection. The product resists physical breakdown and adheres resiliently to pipes as they expand and contract with temperature changes. **HIGH CORROSION RESISTANCE** protects pipes permanently against acids and alkalis found underground. Witcolite is also effective against electrolytic processes. **HIGH WATER RESISTANCE,** results from the surface tension differential between water and Witcolite. No wetting of the underlying surface occurs. **LOWEST COST** of any quality material on an installed basis is an extra plus with Witcolite. *For further information or technical literature on Witcolite, simply write or call the nearest Witco office listed below for your local representative's address.*



Witcolite is delivered to your job site in convenient, easily handled 50 pound multi-wall paper bags.

**WITCO CHEMICAL COMPANY, Inc.**
PIONEER PRODUCTS DIVISION
Dept. 81-01, 122 East 42nd Street, New York 17, N.Y.

SEE OUR CATALOG IN SWEET'S

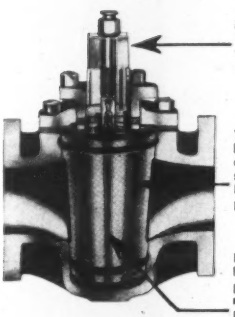
Sales offices: New York • Chicago • Los Angeles • Toronto and Montreal, Canada

# GET PRECISE SYSTEM BALANCING

## with Lubricated Plug Valves

**SIZES TO 36":** Lines above 8" are no longer a problem. Specify sizes and pressure rating to meet your design needs.

**COMPACT:** No bonnet cavity or rising stem saves weight and space.



**PERFECT BALANCE:** Plug is smoothly, easily positioned for precise throttling . . . wrench shows degree of throttle.

**THROTTLE or SHUT-OFF:** If desired, shut-off valve can be eliminated downstream from throttle valve. Positive shut-off assured by pressurized lubricant.

**NO CHANCE OF NOISE:** Solid tapered plug is perfectly seated in rugged body . . . no exposed seats . . . silent for the life of the building.

Since Rockwell-Nordstrom lubricated plug valves are easily positioned to give the exact degree of throttle, many air conditioning design engineers have specified them for new chilled water systems. Pressurized lubricant in the exclusive Sealdport® system gives a tight seal and positive shut-off and lubricant prevents wearing metal-to-metal friction, too. More *plus* benefits of Rockwell-Nordstrom valves: *compact design* (no yoke or bonnet) to fit in tightest areas . . . *quiet operation*, because flow through the valve is smooth and easy . . . and *long life*, because it's a *lubricated* mechanism.

Get all details on Rockwell-Nordstrom, the world's most complete line of lubricated plug valves, lubricants and accessories. Mail the coupon below to Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited. Rockwell International, S. A., Geneva, Switzerland.

ROCKWELL-Nordstrom VALVES

another fine product by

**ROCKWELL**

*Lubrication Makes the Difference*

**Rockwell Manufacturing Company**
**Dept. 110M, Pittsburgh 8, Pa.**

Please send Bulletin V-203.
Please have your representative call.

Name_____ Title_____

Company_____

City_____ Zone____ State_____

SPANG C.W. STEEL PIPE-MADE IN U.S.A.
SPANG C.W. STEEL PIPE-MADE IN U.S.A.
SPANG C.W. STEEL PIPE-MADE IN U.S.A.
SPANG C.W. STEEL PIPE-MADE IN U.S.A.
SPANG C.W. STEEL PIPE-MADE IN U.S.A.

Now, all Spang CW Galvanized Steel Pipe carries this new marking which is your assurance of top-quality domestic steel pipe.

# Look for this marking when you buy steel pipe

**It spells two important advantages for you:**

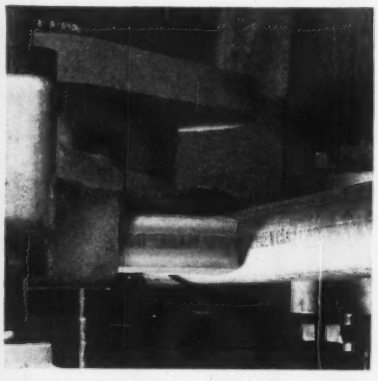
**1.** Pipe made in the United States of America must meet the high product standards set by definite technical specifications established for all pipe manufacturers. When you buy American-made steel pipe, you know you're getting a fine, standard product with good working characteristics and assured long life that will meet specified service requirements.

**2.** The Spang CW Steel Pipe marking indicates that extra measure of quality. When you buy Spang, you know you're getting a product that's carefully controlled during manufacturing and thoroughly tested and inspected before shipping to assure you of a top-quality product, uniform throughout, for fast, economical, trouble-free installations.

Don't take chances by making second-rate installations with questionable foreign imports. It's worth your reputation to buy Steel Pipe made in USA. It pays in the long run!

Look for this Spang marking on your next pipe order. You can't buy a better pipe! Your local Spang Distributor can give you top-quality service. Give him a call!

Steel's Symbol of strength, long life, and economy



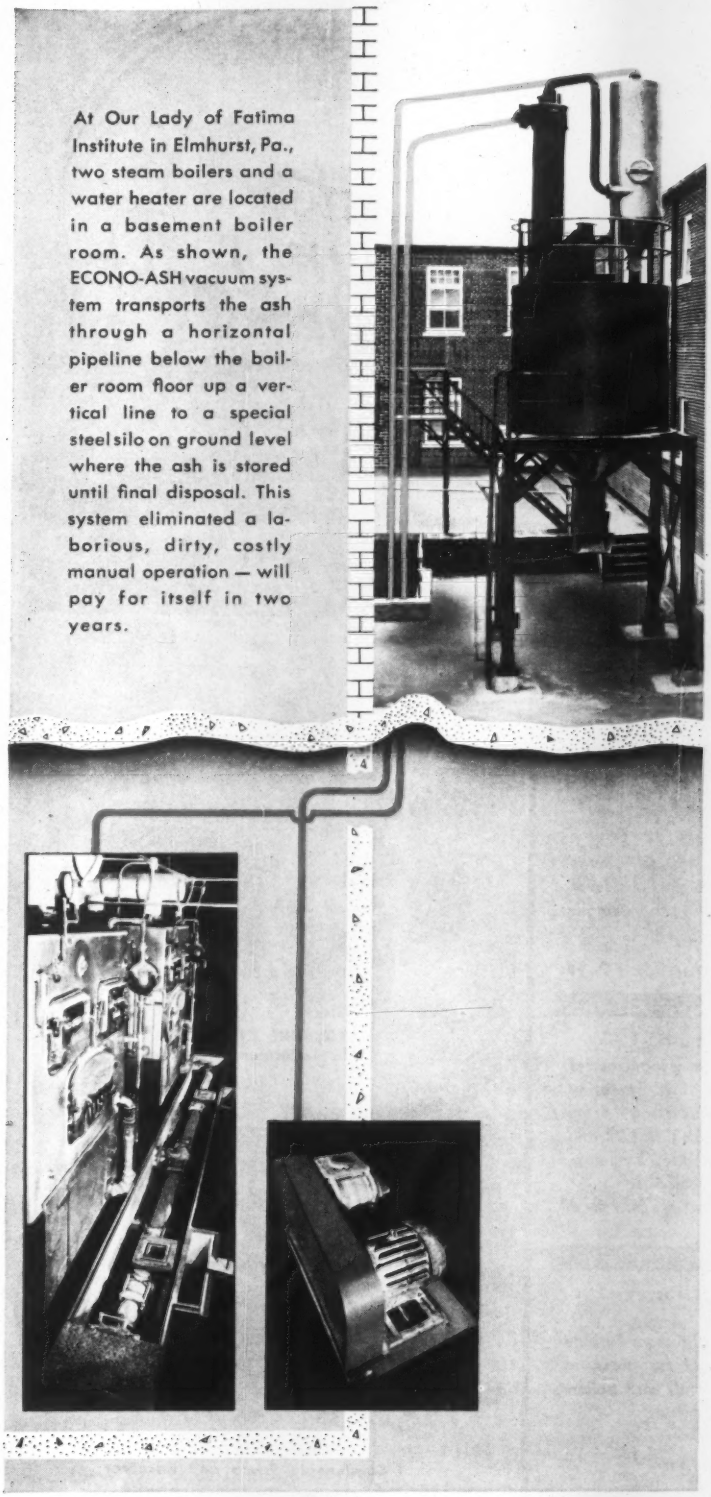
New "Made in USA" marking on Spang CW Galvanized Steel Pipe is applied after pipe has been quick-quenched following galvanizing.

SPANG CW STEEL PIPE

## THE NATIONAL SUPPLY COMPANY

Two Gateway Center, Pittsburgh 22, Pennsylvania

Subsidiary of Armco Steel Corporation



At Our Lady of Fatima Institute in Elmhurst, Pa., two steam boilers and a water heater are located in a basement boiler room. As shown, the ECONO-ASH vacuum system transports the ash through a horizontal pipeline below the boiler room floor up a vertical line to a special steel silo on ground level where the ash is stored until final disposal. This system eliminated a laborious, dirty, costly manual operation — will pay for itself in two years.

# AT LAST

## *An Inexpensive, Fast, Clean Ash Removal System*

## FOR THE SMALL COAL BURNING PLANT

No longer need engineers of small coal-burning plants be saddled with the high costs and inconvenience of manual ash removal. The Allen-Sherman-Hoff Company's new ECONO-ASH System is especially designed for this task. This new pneumatic system is designed to remove ash *on a sound economic basis.*

Here are some of the reasons why. First, the initial cost of the ECONO-ASH System is barely a third of the smallest, most economical conventional ash removal system previously available. Moreover, installation of this pre-engineered package system requires no special skills.

Second, its maintenance costs will pleasantly surprise you because it is a pneumatic system, has few moving parts, few areas of wear.

Third, ash removal with the ECONO-ASH System is so much faster that you'll save significant amounts in labor costs. Normally, your Fireman will remove the ash during his regular tour of duty.

And the big-system cleanliness of the A-S-H ECONO-ASH System will impress everyone from superintendent to casual visitor.

We've prepared a 4-page brochure to explain the new ECONO-ASH System—how it operates, its variations and its advantages. We'll send it to you immediately upon request. It also lists the A-S-H Sales Engineers —one is near you—who will be glad to show you how, in most installations, the ECONO-ASH will pay for itself in two years or less. THE ALLEN-SHERMAN-HOFF COMPANY, 243 East Lancaster Avenue, Wynnewood, Pa.

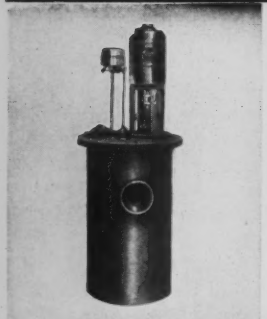
ALLEN-SHERMAN-HOFF

MATERIALS HANDLING SYSTEMS

NO NEED FOR CUSTOM JOB

# Get the most from your pump investment

*A standard type Skidmore Pump will meet the exacting requirements*

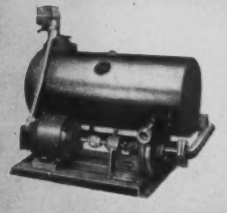


There's a wide range of types and capacities for every heating pump need. Let Skidmore advise you on your next tough job.

**TYPE UV**

*Type UV Condensation Pump is designed for below floor level returns, and is built in single and duplex units.*

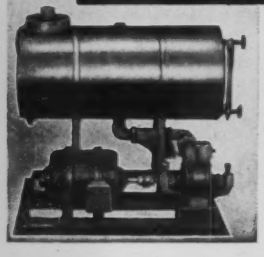
Write for *Bulletin No. 19-A*



**TYPE HS**

*Type HS Pump is recognized for its dependable low operating cost. Capacities range from 1,000 to 65,000 sq. ft. EDR and pressures from 10 to 75 pounds.*

Write for *Bulletin No. 14-A*

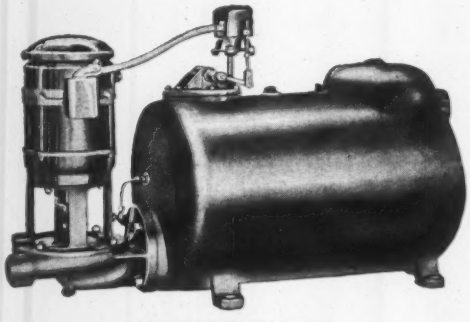


**TYPE TM**

*Type TM High Pressure Turbine Pump. Designed for pressures up to 150 pounds and boilers to 250 H.P.*

Write for *Bulletin No. 17*

**SKIDMORE TYPE "CCVS"**
**Vertical Condensation Pumps**



**SKIDMORE TYPE "VC"**
**Condensate Pump and Receiver**

*Sales representatives in principal cities . . .*
*Call or write for bulletins.*

**SKIDMORE CORPORATION** ST. JOSEPH, MICHIGAN

## Wagner Vertical Solid Shaft Motors . . .

# POWER PACKED PUMP DRIVES

Got pump-power problems? You can solve them—simply, easily—with Wagner Vertical Solid Shaft Polyphase Motors. These motors are designed especially to meet the load conditions of pumping. They handle loads without laboring or stalling . . . are smooth running under cyclic loads. They are uniquely suited, too, for other types of equipment that require vertical motor drives. Match them to agitators, axial fans, centrifuges, mixers, presses . . . anywhere you need a vertical shaft motor.

Whatever the application, one thing is sure . . . Wagner advanced design engineering has produced vertical shaft motors of simple, rugged cast-iron construction . . . motors with plenty of stamina to give you economical, maintenance-free service the year 'round, indoors or out.

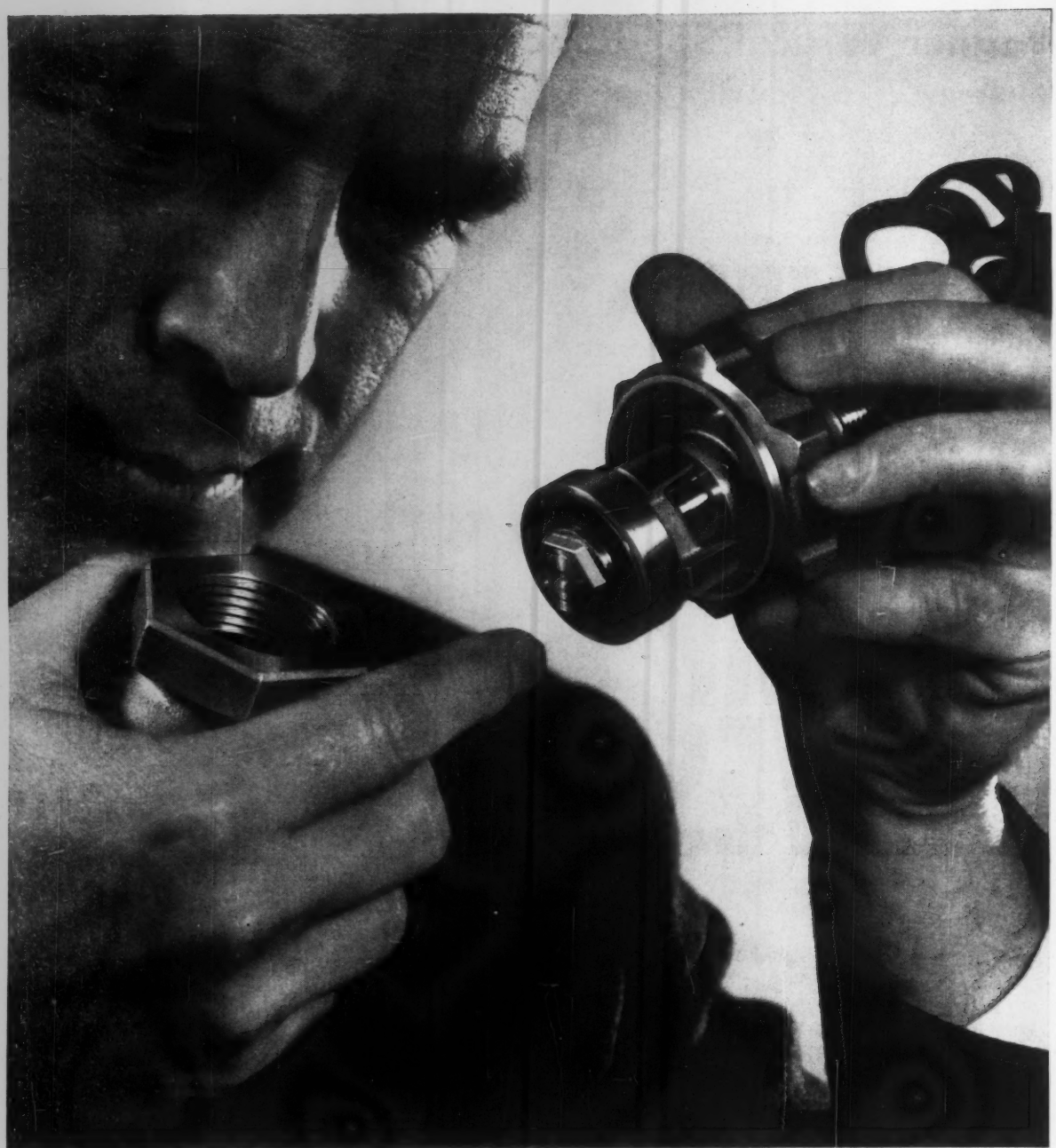
Wagner Vertical Solid Shaft Motors are end-mounted, squirrel-cage type with NEMA Type "P" base. They are available in standard ratings of 60 cycle, 208-220/440 and 550 volt, 1½ through 40 hp—3500 RPM, and 1 through 30 hp—1750 RPM. For information on larger horsepower ratings, call your nearby Wagner Sales Engineer.

Other motor requirements? Wagner can supply standard motors or build special motors to fit your needs. More than 65 years of constant research and development in electric motor design has made Wagner a name you can depend on. For an analysis of your next motor application, be it for plant or product call on Wagner. There are 32 branch offices in principal cities across the country.

**Wagner Electric Corporation**
6370 Plymouth Ave., St. Louis 33, Missouri

WM60-4

**SERVING 2 GREAT GROWTH INDUSTRIES — *ELECTRICAL — AUTOMOTIVE***



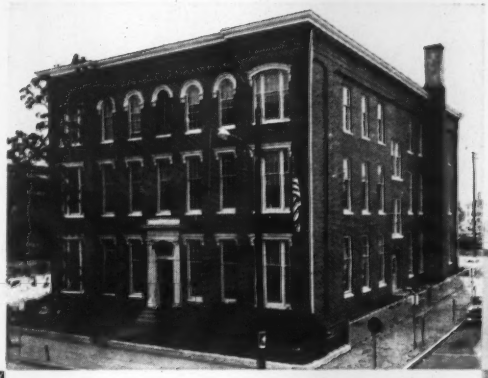
**MEN WHO KNOW VALVES** look for the free-swiveling disc holder—know it keeps disc from grinding on seat, chops maintenance costs, assures leak-proof closure. It's an O-B feature—one of many improvements you get by standardizing on the complete O-B bronze valve line. Ask your O-B distributor for the valve in the orange-and-black box.

OHIO BRASS COMPANY • Mansfield, Ohio

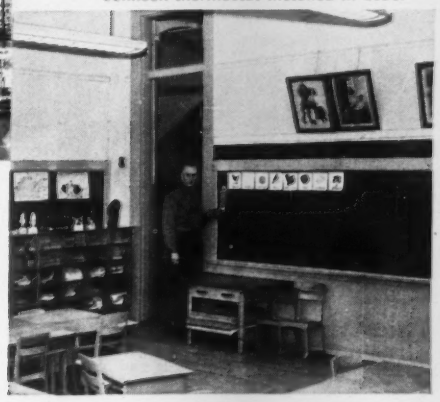
**O-B VALVES**

B HOLAN

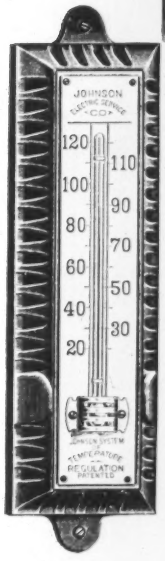
10072-V



George W. Morris School, Louisville, Kentucky. Built in 1852, it still functions efficiently thanks to good maintenance and wise selection of original materials and equipment.



Howard Smith, Heating Shop Supervisor, Louisville Board of Education, inspects a Johnson thermostat installed in 1890.




# 1890: JOHNSON control system installed

# 1960: still going strong—70 years later!

## Oldest known automatic temperature control installation provides comfort and economy in 108-year old school

George W. Morris School in Louisville, Kentucky, has what is undoubtedly the oldest automatic temperature control system in the world.

This Johnson Pneumatic Control System was installed in 1890 to control a new blast heating system and provide individual room temperature regulation. More Johnson Thermostats and Valves were installed in 1914 when supplementary direct radiation heating was added. For 70 years, the Johnson System has served this school dependably and economically . . . returning many times its cost in fuel savings while assuring classroom comfort for thousands of students.

Johnson Pneumatic Control Systems have always been designed to provide reliable, trouble-free temperature control for the life of a building. Countless Johnson Systems installed 40 or 50 years or more ago are still giving first-class service.

Isn't this the kind of efficiency and economy *your* clients are seeking? It's a key reason why so many owners count on Johnson for the finest in temperature control at the lowest possible lifetime cost. Give your clients the benefits of Johnson Pneumatic Control, the system you can recommend with complete confidence in its future performance — for the life of the building. Johnson Service Company, Milwaukee 1, Wisconsin. 105 Direct Branch Offices.

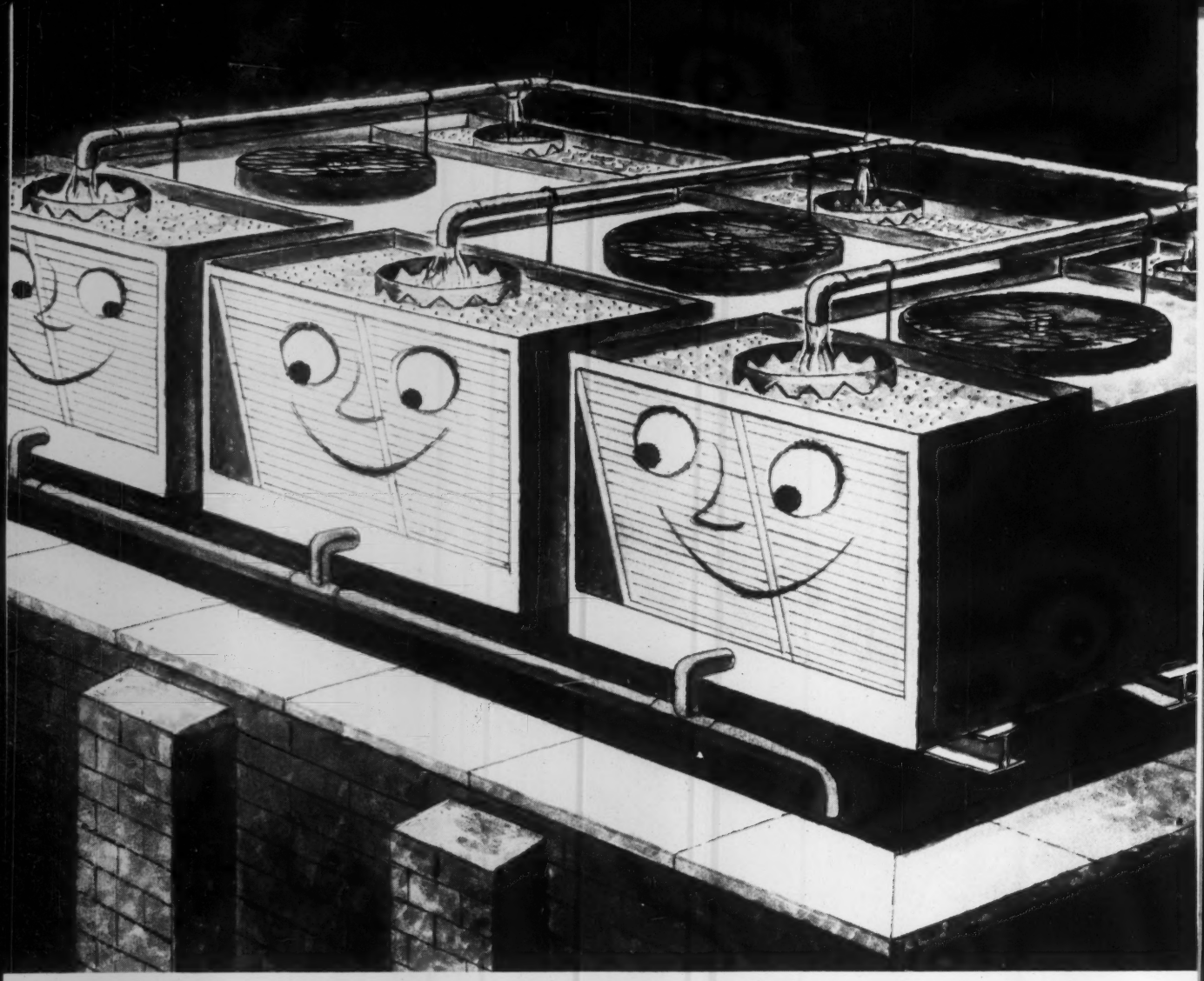
Johnson Valves installed in 1890 and 1914 still operate the hot blast heating system.

OUR 75TH YEAR

**JOHNSON CONTROL**

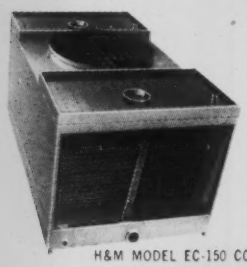
PNEUMATIC SYSTEMS

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885



# How to cut costs on a 450-ton cooling job:

## *Use three Halstead & Mitchell 150-ton cooling towers!*



H&M MODEL EC-150 COOLING TOWER
WITH 10-GAUGE STEEL CABINET

HM
**Halstead & Mitchell**

How can three units be cheaper than one? Simple. Halstead & Mitchell packaged cooling towers come to you completely assembled and therefore less expensive to install. They operate at lower cost because there can be no wasted capacity; with step-control, you get capacity as you need it.

Furthermore, with "modular" units, you can place each tower near the equipment it's to be used with. This gives you closer control of water temperatures—another economy factor. Then, too, if one tower must be shut down, you can continue to operate the others.

The advantages go on and on: lower silhouette, lower rigging costs, and utmost flexibility—towers can be easily moved or supplemented as requirements change. And, like all H&M towers, these carry the exclusive 20-Year Guarantee on the wetted deck against failure due to fungus attack or rotting.

Contact your Halstead & Mitchell distributor for complete information on H&M cooling towers in 3- to 150-ton capacities. Or write Halstead & Mitchell Co., Bessemer Bldg., Pittsburgh 22, Pa.

Cooling Towers • Water-Cooled Condensers • Air-Cooled Condensers • Finned Coil Products • Air-Handlers

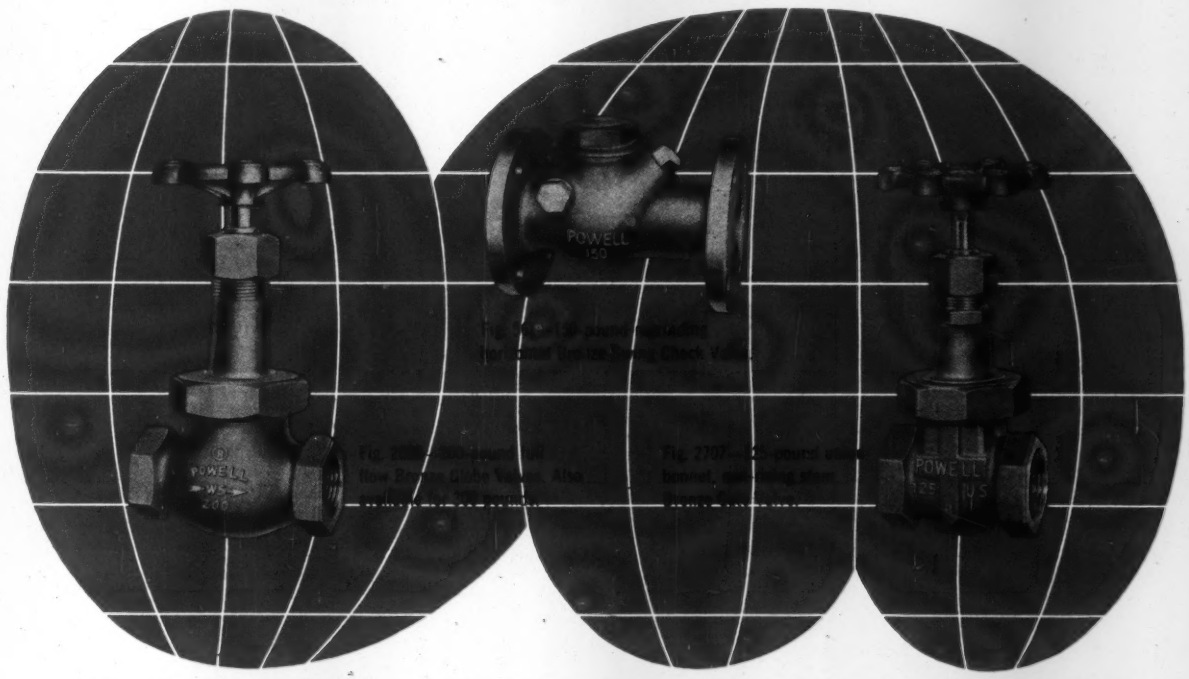
# POWELL BRONZE VALVES

## performance that makes a world of difference

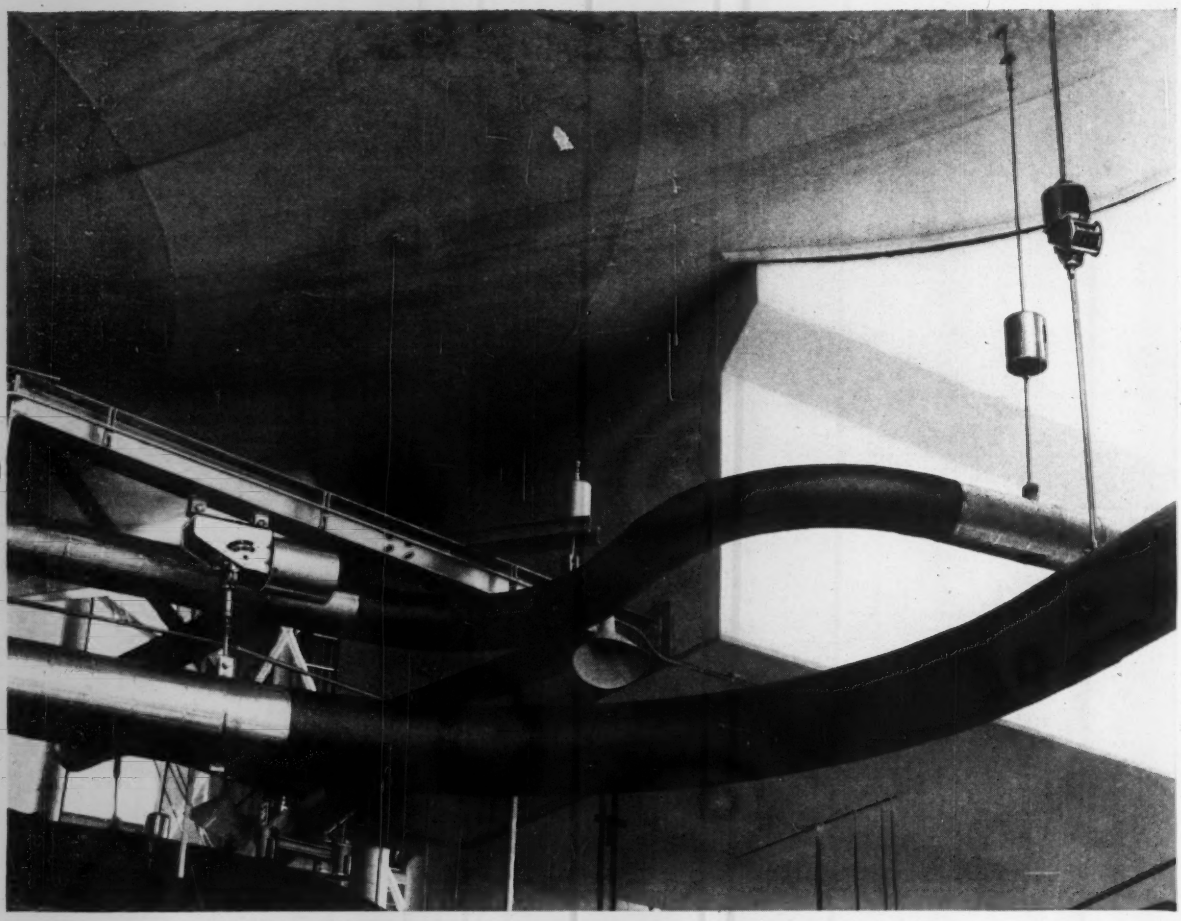
BRONZE—Ancient symbol of greatness and strength—is still one of the basic materials used by Powell in the manufacture of quality valves for modern industry. Also—Powell offers a complete line of iron, steel and corrosion-resistant valves—all types—in all popular sizes—to satisfactorily take care of every one of your flow control requirements.

For the full details, on Powell bronze and other valves, check your Powell valve distributor—or write directly to us for illustrated literature.

## Powell . . . world's largest family of valves




THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO



**Grinnell Spring Hangers** support the pipes carrying steam from the heat exchangers to the turbines.

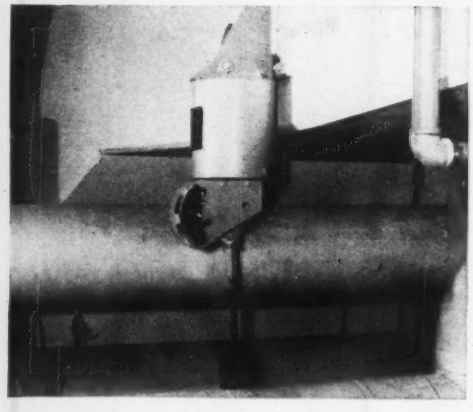
# Grinnell Hangers cradle high-pressure piping at new Yankee Atomic Power Plant

At the new Yankee Atomic Power Plant in Rowe, Mass., uranium fuel in the nuclear reactor keeps the water which flows through the reactor at about 500°F. This pressurized water, at 2,000 pounds per square inch pressure, transfers the heat through piping to a steam generator where steam is produced for running power turbines.

Piping that undergoes such high pressures and temperatures must have rugged, *reliable* support. Chosen for this tough job: Grinnell Pipe Hangers!

Grinnell Constant Support Hangers are used where reactive forces at terminal points must be kept within specified limits. Grinnell Variable Spring Hangers are used where piping is subject to vertical movement and does not require a constant support type.

For a complete line of engineered pipe hangers and supports . . . for skilled advice and assistance . . . for experienced field engineering service . . . call on Grinnell Company, Providence 1, Rhode Island.



Turbine extraction lead gets support from Grinnell Constant Support Hanger

**GRINNELL** AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Pipe Fittings, Valves, Pipe Hangers, Prefabricated Piping, Unit Heaters and Piping Specialties • Branch Warehouses and Distributors from Coast to Coast

# WING

VARI-JET

# HEATERS

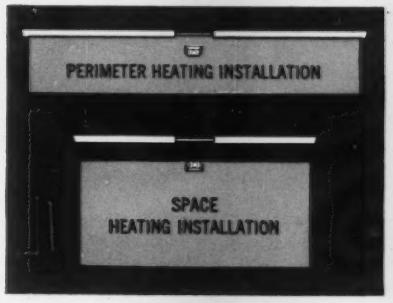
## now provide perimeter or space heating too

Wing Door Heaters are needed wherever large doors must be opened during cold weather. They keep all workers in the area of the door comfortable and protected from cold chilling drafts. The high velocity, warm air blanket thrown over the doorway tempers the incoming flow of cold air eliminating worker complaints, absences and loss of production.

Wing Door Heaters, with the new dual purpose door heater or perimeter/space heater discharge is the only one available that gives this full time service. The door switch and room thermostat controls automatically position the discharge damper to suit the heating need.

Thousands of installations throughout industry have proved the effectiveness of the design and usefulness of standard Wing Door Heaters. For more information write today for bulletin DDH-60.

The Wing Door Heater shown is equipped with the new dual purpose Vari-Jet discharge which automatically adjusts the heat flow pattern to blanket the doorway when the door is open and to provide perimeter or room heating—as shown in the drawings below—when the door is closed.

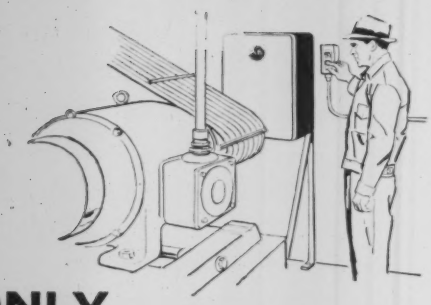



WING

**L. J. WING MFG. CO.** Division of Aero Supply Mfg. Co. Inc., Linden, New Jersey

FACTORIES: LINDEN, N. J.; MONTREAL, CANADA; IN EUROPE: WANSON, HAEN-NORD, BRUSSELS, BELGIUM

Other Wing products: Revolving and stationary discharge unit heaters. Fresh air supply units. Axial flow fans. Power roof ventilators. Draft inducers. Turbine and motor blowers. WC 155

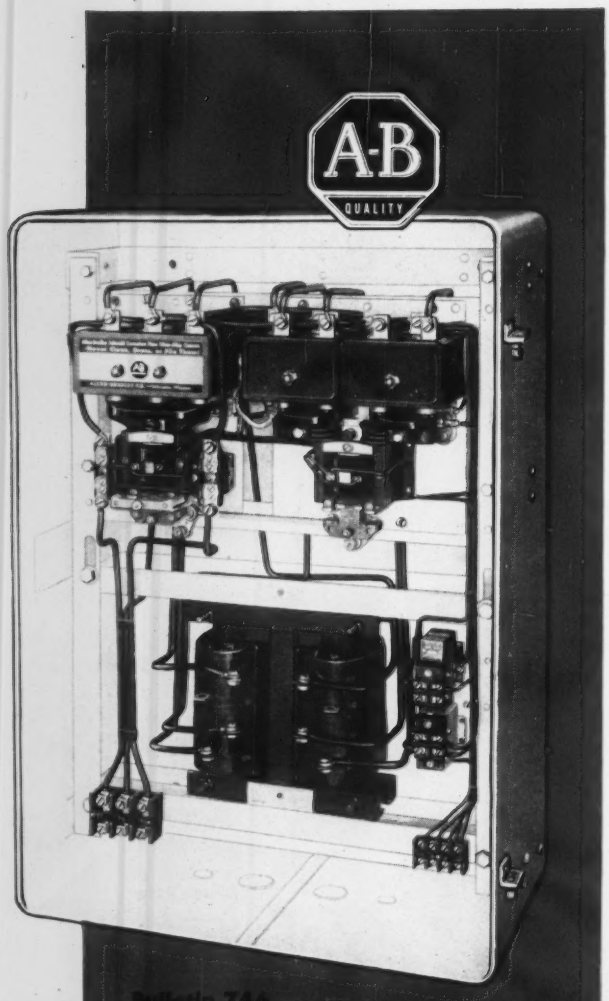


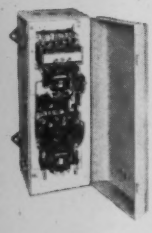
# ONLY ALLEN-BRADLEY CAN PROVIDE ALL THE ANSWERS

## —for reduced voltage starting of heavily loaded compressor motors

The broad line of Allen-Bradley reduced voltage starters makes possible a selection of the best starter for any air conditioning system—nôt only to meet the power company's requirements but also to provide the best starting conditions for the motor and the compressor.

The simple solenoid contactors in A-B reduced voltage starters have only ONE moving part—assuring millions of trouble free operations. And their double break, silver alloy contacts never need costly maintenance. Accurate, reliable overload relays protect motors against burnouts. Write for Publication 6088.



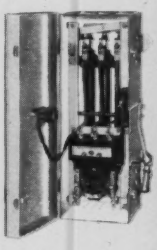



**Bulletin 740**

Graphite disc resistors are automatically inserted in series with the squirrel cage motor at starting, and they are automatically cut out after a predetermined time. Turning a single screw on the starter frame adjusts the compression resistors exactly to motor and load conditions for velvet smooth acceleration. Ratings to 200 hp, 220-440-550 v.

**Bulletin 640**

Where remote control is not needed, these graphite compression disc resistor starters provide stepless acceleration of squirrel cage motors. Operated by hand lever, the smooth starting of the motor is under the control of the operator. No-voltage and dependable overload protection is provided. Ratings to 200 hp, 220-440-550 v.



**Bulletin 746**

Automatic reduced voltage starter for squirrel cage motors that should not be started on full line voltage. It employs autotransformer connected in open delta to reduce line voltage during starting. Adjustable timing relay controls starting period. Taps are provided on the autotransformer to adjust the starting voltage applied to the motor. Ratings to 300 hp, 220 v. 600 hp, 440-550 v.

Allen-Bradley Co., 1335 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

# ALLEN-BRADLEY

Member of NEMA

*Quality* Motor Control

**have trouble specifying heating and air conditioning from ten different firms?**



* one way to solve your problems is with . . .



*Important Information Available!*

Lennox Industries Inc., Dept. 1-45
Marshalltown, Iowa

Gentlemen:

I am interested in the items checked below. Please mail complete information to me on . . .

- ☐ Direct-fired industrial heaters
- ☐ Unit heaters
- ☐ Gas Duct heaters
- ☐ LENNOX APPLICATION MANUAL (Industrial direct-fired space heaters)
- ☐ Have a LENNOX representative call

Name_____

Address_____

City_____ Zone____ State____

# Important Information Available!

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
FIRST CLASS PERMIT NO. 53 MARSHALLTOWN, IOWA

**LENNOX INDUSTRIES INC.**
**DEPT. 1-456**
**MARSHALLTOWN, IOWA**

Postage Will Be Paid by Addressee

### *Unit heaters*

These unit heaters are ideal for supplementary heating such as heating loading dock and storage areas. They range in size from 80,000 to 250,000 Btuh.



### *GSDI duct heater*

The GSDI duct heater can be used with existing duct systems as added heat or can be used as a forced air space heater when connected to a blower. Available from 120,000 to 420,000 Btuh.



### *"Landmark"*

The Lennox "Landmark" is extremely versatile, because of its modular design. Ideal for heating and cooling smaller areas or, if used as multiple units, capable of handling larger areas. Air conditioning is an integral part of the Landmark system.



### *Lennox oil "Stowaway"*

Where space is at a premium and capacity demands not too great, the Lennox Oil "Stowaway" line is an ideal solution. These units range in size from 119,000 through 350,000 Btuh.



### *OG4 industrial heaters*

Here is the "big boy" of the Lennox line...the OG4 combination gas-oil industrial heater. Lennox industrial heaters have a range from 280,000 through 2,000,000 Btuh. Lennox industrial heaters can be installed either vertically, horizontally or inverted.



### *Air conditioning*

Lennox Air Conditioning has been designed to work as an integrated part of the various heating units. Seventeen-ton condenser shown here is but one of the many units in the extensive Lennox line of air conditioning equipment.

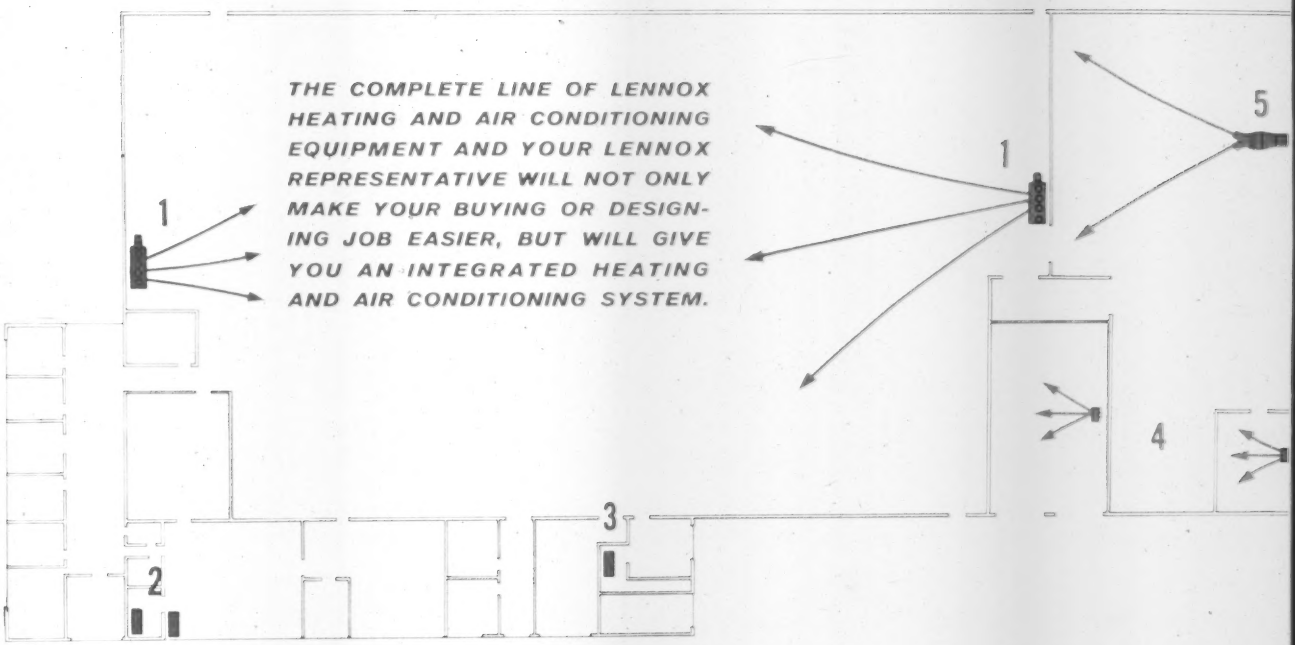


***These are just a few of over four hundred units in the extensive Lennox line of heating and cooling equipment.***

**There's no guess work or "make do" with Lennox equipment . . .** This broad line of equipment meets every heating and air conditioning requirement. In the New York plant shown here, for instance, several types of heating and cooling problems faced the engineers. Each area in the plant had its own heating and cooling peculiarities and needs. By utilizing several types of Lennox models, each problem was solved easily. The results: properly sized units that deliver top heating and cooling at a sensible cost.

- direct-fired vs "wet" industrial heating
- heating and air conditioning
- make-up air and ventilation
- process work
- space heating

*THE COMPLETE LINE OF LENNOX HEATING AND AIR CONDITIONING EQUIPMENT AND YOUR LENNOX REPRESENTATIVE WILL NOT ONLY MAKE YOUR BUYING OR DESIGNING JOB EASIER, BUT WILL GIVE YOU AN INTEGRATED HEATING AND AIR CONDITIONING SYSTEM.*




(1) Two Lennox OG4 Industrial Heaters, delivering a total of 1,260,000 Btuh, heat 10,600 sq. ft. of manufacturing area. Although air nozzles are installed here, ductwork can also be used if the job conditions require it.

(2) Two Lennox "Landmark" heating and cooling units supplying a total of 238,000 Btuh, 12 tons of cooling maintain year around comfort in 4,800 sq. ft. of office area. Supply ducts are located in concrete slab with outlets at perimeter.

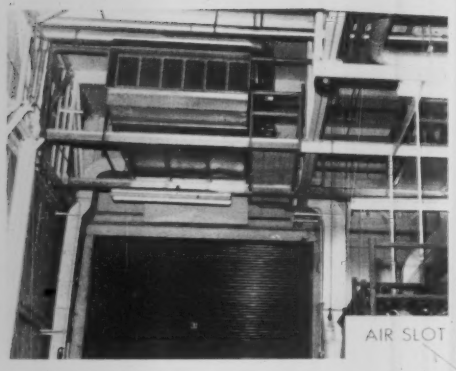
(3) A third Lennox "Landmark" unit heats remote supply and mailing areas.

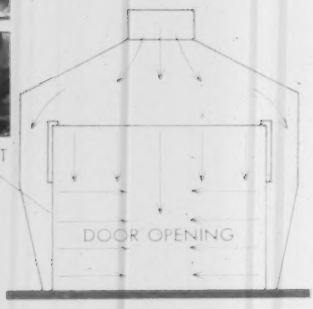
(4) Two Lennox gas heaters add supplemental heating to loading and storage areas.

(5) Single Lennox gas duct heater with a Lennox packaged blower suspended from the ceiling heats 7,000 sq. ft. with 420,000 Btuh. Cooling may be added if desired.

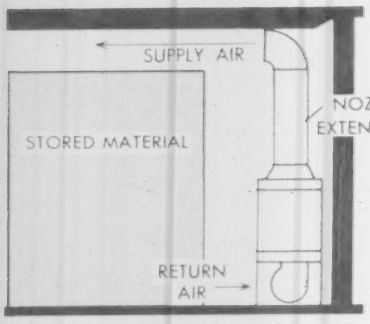
**LENNOX**®

*industrial heating and cooling equipment*

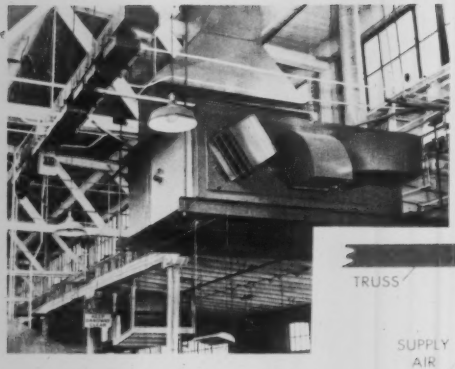


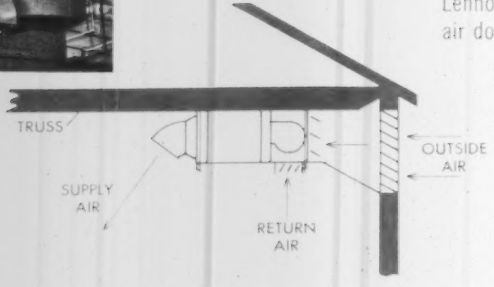




A problem frequently encountered in industrial heating is the infiltration of cold outside air into a heated space through large loading doors that are in frequent use. The most successful method of preventing the entrance of this cold air into the heated space is to surround the doorway with slot openings through which heated air is discharged at a velocity sufficient to blanket the opening. Note the line drawing and picture illustration of this method of heating.




Another problem encountered in various plants and warehouses are buildings used for storing materials. The volume of stored material leaves only aisleways and clearance from the pile to the roof line to circulate heated air. A simple and inexpensive solution to this problem is to provide air nozzle extensions which are simply round pipes that elevate the heated air stream discharge above the height of the stored material.






If floor space is unobtainable for the location of direct-fired space heaters, the next best thing is to suspend the units from the ceiling.

Lennox industrial heaters are available with service platforms for suspension purposes.

Lennox blowers are sized to push the heated air down to the work area where it belongs.

**LENNOX Industries Inc.**

MARSHALLTOWN, IOWA • COLUMBUS, OHIO • SYRACUSE, N.Y. • FORT WORTH, TEXAS • LOS ANGELES, CALIF. • SALT LAKE CITY, UTAH
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LITHO U. S. A.

FORM NO. IND.-602-M2

# you'll want to know...

## *Biggest Air Conditioning System Slated For New York's Chase Manhattan Bank Building*

THE WORLD'S sixth largest office building is requiring the biggest air conditioning systems ever installed in such a structure.

The new $131 million Chase Manhattan bank in downtown New York is 64 stories tall, will have nearly 2 million sq ft of floor space, a population of 15,000 employees, and 10,000 visitors daily. To keep them comfortable, 51 air-handling systems will circulate 2 million cfm of temperature controlled air day and night.

Punctuating the anodized aluminum exterior and compounding the air conditioning job are 8800 windows with an area of 800,000 sq ft. Other complications arise from the office machines and lights. Lights alone will give off 17 million Btu per hr. Peak heat output from the entire building will be over 275 million Btu per hr.

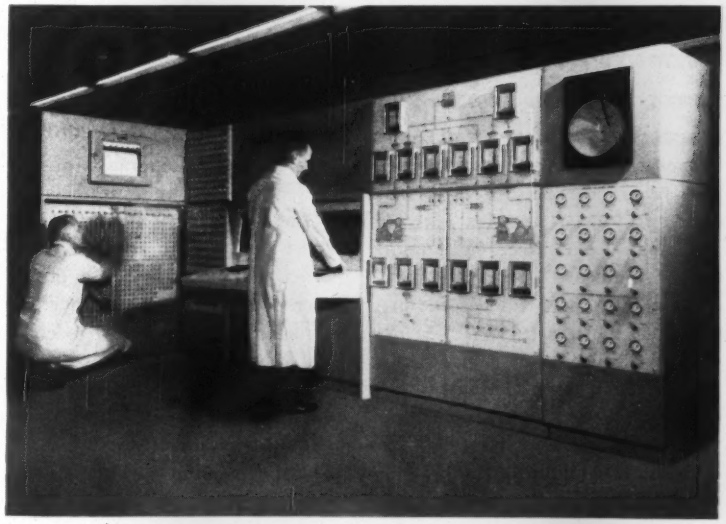
To handle this load the building will have 9100 tons of cooling capacity. Four centrifugal compressors, claimed to be the largest of their type, will do the job.

The building is "divided" at the 22nd story for air conditioning purposes. The first 21 stories plus the five story basement are on one system; a second system serves the 22nd to 60th floors. The top four floors contain mechanical equipment and do not require air conditioning.

Each floor has a four-zone interior system supplemented by a perimeter system.

The interior system uses medium-velocity, medium-pressure air. Temperatures for each zone on every floor are individually controlled.

Eighteen perimeter systems circulate high-pressure air at high velocity through 7000 induction units. Low-pressure air will be circulated through ceiling diffusers on the five basement levels. All air



ENGINEERS make last-minute check on one of the giant control centers for the Chase Manhattan Bank Building. The center will control 51 air-handling systems, 3000 thermostats, 4000 valves, and 9100 tons of cooling equipment

you'll want to know

for the building will pass through electronic air cleaners.

Two giant control centers will be used with the systems. One will be on the 11th floor, and the other on the 31st floor. Only two engineers will be required to control comfort throughout the 64 story structure, according to Minneapolis-Honeywell Regulator Co.

Each of the control panels has two viewing screens: the left screen will show the air handling systems and converters; the screen on the right will contain floor plans. In addition, when a particular area is being viewed, temperature readings are given from various points within that area.

Together the two control centers will use more than 20 miles of wiring and 50 miles of pneumatic tubing to bring information to the building engineers. More than 450 thermostats are scattered throughout the building to control individual zone temperatures, in effect second-guessing operation of 2500 other thermostats and regulating some 1000 valves.

## Commercial-Industrial Oil Burner Sales on Increase

COMMERCIAL AND INDUSTRIAL oil burner sales are on the increase this year, according to the Oil Heat Institute of America Market Research Committee. Manufacturer shipments for August amounted to 2040, a 4 percent increase over August 1959.

Total shipments of commercial-industrial burners reported by the OHI of America as of September 1, are 5299 horizontal rotary cup burners, 8020 high pressure and low pressure self-powered gun burners, and 271 mechanical air-steam atomizing burners equipped with air registers.

## World Adopts New Standard of Length

THE WORLD has adopted a new international standard of length — a wavelength of light — replacing the meter bar which has served as the standard for over 70 years. The action was taken by the 11th General Conference on Weights and Measures, which met recently in Paris, France.

The new definition of the meter is 1,650,763.73 wavelengths of the orange-red line of krypton 86, replacing the platinum-iridium meter bar kept at Paris as an international standard for length since 1889 under the Treaty of the Meter. The change is significant in that it will no longer be necessary to rely on the Paris standard for absolute accuracy.

Above, a National Bureau of Standards scientist adjusts a krypton-86 lamp in its liquid nitrogen bath. The lamp is operated at the triple point of liquid nitrogen, 63 K, to increase wavelength stability.

## *Research Program Continues On Thermoelectric Cooling Devices*

THE CURRENT research program on materials and techniques for thermoelectric cooling devices at Battelle Memorial Institute will be extended for two years, it was announced recently by Dr. E. H. Lougher, who is coordinating the program.

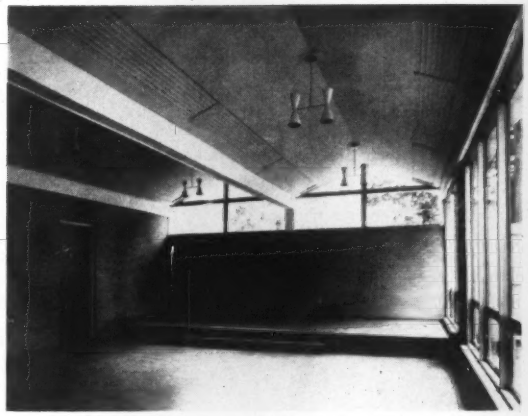
The principal objective of the research has been and will continue to be the preparation of new compounds and the investigation of their resistivity, thermal conductivity, and thermoelectric power. Emphasis is being placed on the thermoelectric properties of materials which have received relatively little attention, as distinguished from such materials as bismuth telluride which have been heavily investigated.

Complementing the major effort at the Columbus facility, physicists in Battelle's Geneva (Switzerland) laboratories are engaged in a theoretical study of lattice thermal conductivity.

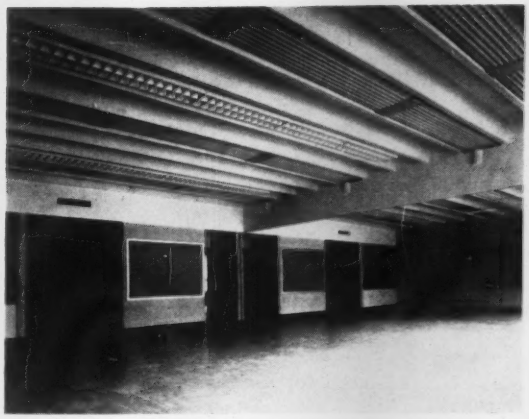
Dr. Lougher indicated that substantial progress has been made during the last two years. At least one compound has been found to have promise as a thermoelectric cooling material, although it has not been determined whether materials based on this compound will be competitive with the better thermoelectric alloys now commercially available.

Perhaps as important, said the Battelle scientist, "new theoretical techniques have been developed which aid immeasureably in screening and improving compounds and alloys." This theoretical approach has reduced greatly the amount of experimental work required to predict the maximum thermoelectric figure of merit attainable in a given material.

Materials for study were selected from the following chemical



UNIT A with panels set flush in sloping ceiling



UNIT B has panels set between tee sections of slabs

# Prefab Copper Radiant Panels Heat Cincinnati Child Care Center

RADIANT HEATING supplied by prefab units of inflatable copper tubing running through solid sheets of copper has been installed in a child care center in Cincinnati.

Wesley Child Care Center, built for a religious group, accommodates 80 children for periods up to eight hours. The center consists of two new buildings which total 10,100 sq ft. They are integrated with an existing structure and joined by an enclosed corridor.

The heating plant consists of a gas-fired boiler which supplies hot water for circulation to the radiant panels. The panels are located in the ceiling of each room, according to Revere Copper and Brass, Inc.

Unit A contains a chapel, offices, kitchen, isolation room, toilets, and storage room. It has a multi-gabled wood roof and a plastered ceiling that follows the roof line. In this unit, the panels are set flush in the sloping ceiling.

Unit B has four classrooms, multi-purpose and dining areas, a kitchen, boiler room, and toilets. The undersides of precast, prestressed concrete slabs form the ceiling. The panels are set between the tee sections of the precast slabs and flush with their lower edge.

The radiant heating system throughout the center is supplemented by warm air from the ventilating system.

A. M. Kinney Associates, architectural and engineering firm, designed the center.

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systems: compounds of copper, silver, and gold with sulfur, selenium and tellurium; compounds of zinc, cadmium and mercury with arsenic, antimony, and bismuth; compounds of alkaline-earth metals, such as magnesium and calcium, with germanium, tin, lead, arsenic, antimony, and bismuth; and compounds of alkali metals, such as sodium and potassium, with germanium, tin, lead, arsenic, antimony, and bismuth. In addition, alloys of some of these compounds are being studied. To date, study has been directed toward the first three of the previously named systems.

# IHF Discusses Dust Control

THE DISCUSSION of dust control played a major role in the 25th annual meeting of the Industrial Hygiene Foundation held October 26 and 27 at Mellon Institute.

A discussion of trends in municipal air-pollution legislation was led by V. G. MacKenzie, Chief, Div. of Air Pollution, U.S. Public Health Service. The question of whether standards are needed, can be set up, and are practical was considered.

A paper on "How We Can Achieve Better Operation of Dust Control Systems" was presented by Knowlton J. Caplan, Mallinckrodt Chemical Works, Uranium Div. Mr. Caplan pointed out that since the capital returns of dust control are often intangible — more healthful working conditions, improved worker efficiency, better labor relations — industrial organizations frequently neglect the systems they have installed. Farsighted management, he said, "will install dust control . . . and then see to it that the return is obtained."

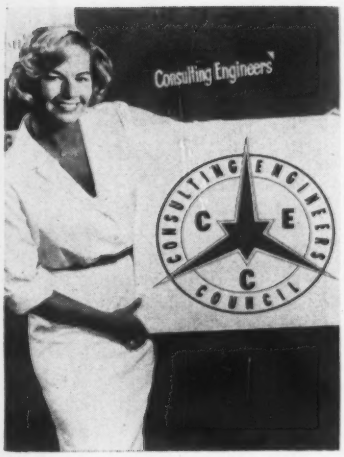
## C. E. C. Insignia Gains In National Popularity

THE NEW INSIGNIA of the Consulting Engineers Council is reported being used more and more. This follows the Council's adoption of the official insignia at its annual meeting last May.

The three-pointed star emblem is the first and only recognized national insignia of the association. It is designed for use on all C.E.C. material, such as stationery, publications, meeting banners, and telephone listings. Its use on drawings or specifications is prohibited, however.

W. O. Stevens, of W. O. Stevens & Co., Mercer Island, Wash., said the insignia design is not intended as a trade mark, "but rather as an index of performance or professional integrity." Mr. Stevens designed the insignia in 1957 as part of a national competition. He is a past president of the Consulting Engineers Association of Washington.

The new C. E. C. insignia is being shown at the right.




## Warm Air Duct Radiant Heating Successful in Greenhouse Application

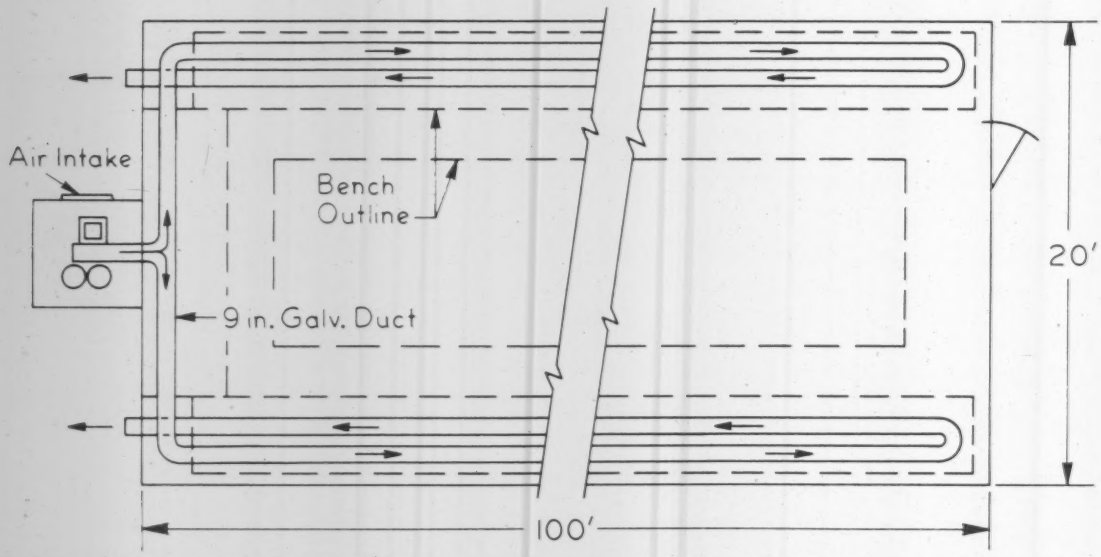
ELEVEN YEARS of using warm air radiant heating systems for maintaining controlled temperatures in their greenhouses have convinced two horticulturists that the system can't be beat, according to Jack Janofsky of the Kilbury Mfg. Co.

It was in 1949 that Clyde Soeten, Orchid Research Co., Altadena, Calif., installed a then unique kind of heating system in his 12 × 15 ft orchid house. Benches which hold the seedling orchid plants are heated from below by 6 in. round ducts. Supplying the heat is a direct-fired, blower-type gas heater which keeps the soil as warm or warmer than the ambient air temperature.

Soon after this installation, Rolan Howard, Hawthorne, Calif., installed a 100,000 Btu per hr heater in a 20 × 100 ft orchid house. Over 410 ft of 9 in. round galvanized metal ducts are used in circulating the warm air under the benches supporting the orchids. However, the air is not recirculated; it is exhausted to the outside after all the heat has been transferred to the room.

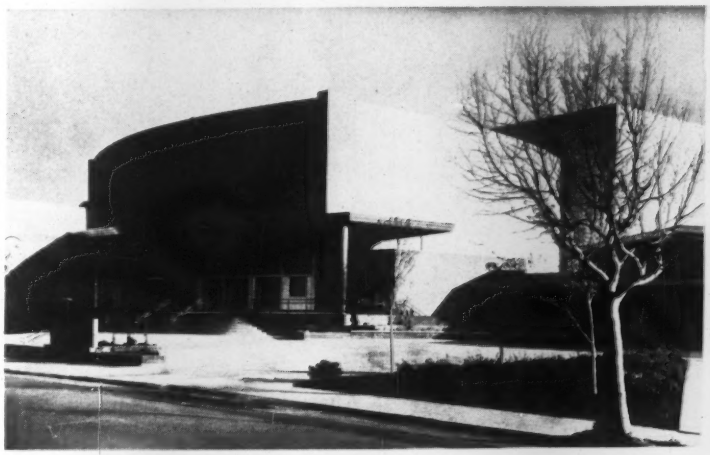
In cold weather the heater operates continuously and maintains a temperature difference of 20 F above outside freezing temperature.

Because of the simplicity of the system, little maintenance has been necessary.




FLOOR PLAN of greenhouse shows galvanized metal duct system that runs under the benches supporting the orchids. Note that warm air in system is not recirculated, but is exhausted after heat has been transferred to the room

# New High School Building Gets Flexible Air Conditioning System



UNUSUAL diversity of building usage in the new Creative Arts Building of Pittsburg, Calif., High School created special problems in the design of an air conditioning system that would accommodate the structure. While the building is generally not in complete use, one or more areas are usually always occupied.

The brick and concrete structure covers a 70,000 sq ft area. It includes an auditorium and balcony with 2000 seats, a separate little theater which accommodates 250, plus band, choral, radio, and photography rooms.

Varying temperature conditions between the balcony and the lower sections of the main auditorium, plus the non-use of some areas of the building, necessitated zone control. Simplified system operation was desired because the air conditioning plant had to be operated and maintained by the building custodian, according to The Trane Co.

A hermetically sealed centrifugal water chiller is used to provide the cooling needed. A cast iron water boiler, rated at 80 psi working pressure, is used for the central heating system.

Flexibility was built into the system to provide heating, cooling, and dehumidification simultaneously throughout the various building zones.

A graphic supervisory data center installed in the central mechanical equipment room indicates dry bulb temperatures throughout the various zones and other critical data in the system. The data center was installed with provisions for reset as required remotely from the central control in the data center panel.

The data center panel automatically programs the chilled and hot water demands as dictated by the various zone thermostats and humidistats throughout the building.

A central chilled water pump circulates chilled water in a closed loop in the chiller room. For each conditioning unit, an individual circulating pump draws water as required from the main chiller loop and delivers chilled water blended with bypass water to its zone cooling coil.

Water from the chilled water coil is either returned to the chiller for recooling, or bypassed through a three-way blending valve at the suction of the pump circulator, to provide the desired water temperature at the cooling coil. Blended water is circulated through the particular cooling coil at temperatures demanded by the space thermostat or for dehumidification as called for by the space humidistat. Reheat is provided by a hot water coil downstream from the cooling coil.

Cooling and dehumidification is accomplished by an eight-row chilled water coil in the central air conditioning plant that serves the main auditorium. Cooling and dehumidification in remote areas is accomplished by four and six-row chilled water coils as required.

In lieu of the conventional face and bypass arrangement for cooling and dehumidification using a constant temperature cooling coil, constant water volume is used but with the temperature of the water varied by blending bypass water with chilled water through a three-way modulating mixing valve to attain the conditions desired. Heating is provided in a similar manner to cooling.

Additional refinement is built into the main auditorium controls as follows: A reheat coil is located downstream from the cooling coil which brings the dry bulb temperature back to 60 F after dehumidification. Booster coils are provided for each zone to make final adjustments to the dry bulb temperatures of the supply air to the respective zones.

Temperature controls are electronic-pneumatic. Space temperatures are maintained within a range of $\pm 1$ F and relative humidities are maintained within limits of $\pm$ 2 percent in each zone.

The Creative Arts Building was designed by Cantin & Cantin, architects. The mechanical engineer was Sanford W. Fox, consulting engineer. The systems were installed by Coast Ventilating and Heating Co.

# UN Energy Conference To Meet in Rome, 1961

PRACTICAL PROBLEMS and experience in the utilization of solar energy, wind power, and geothermal energy will be examined carefully in Rome next year, August 21-31, by the United Nations Conference on New Sources of Energy.

The Conference will make special reference to the problems of less developed countries which have a shortage of conventional energy resources. Practical applications will be stressed rather than scientific principles or basic research. Lines of action which have already led, or are about to lead to commercial applications will have first consideration.

The aim of the Conference is to bring together all the experts in the fields, as well as people interested in power development in general. Technical papers will be published on the various subjects in both the English and French languages. This will provide participants with up-to-date information on progress achieved, and will facilitate an exchange of views and experiences relating to practical problems, potentialities, and limitations in utilizing these three sources of energy.

The agenda provides for two parallel series of technical discussions. One will be devoted to the utilization of the energy sources for power purposes, and the other devoted to discussing solar energy for purposes other than power.

Participation at the Conference will be by invitation issued by the Secretary-General of the UN, Dag Hammarskjold. Participants will be selected from qualified persons who have been nominated to attend. Nomination consists of filing an application for an invitation, along with a preliminary abstract of the technical paper to be presented. Either a group or an individual may file for an invitation.

For further information and application forms, write to Alfred G. Katzin, Executive Secretary, United Nations Conference on New Sources of Energy, United Nations, New York.

## New Convention Hall Requires 4000 Fittings

MORE THAN 4000 welding fittings were used along with 20 miles of piping in the construction of the heating and air conditioning system for Chicago's new exposition center, McCormick Place, according to the Tube Turns Div., Chemetron Corp.

The center is served by one of the biggest heating installations in the country, costing over $1 million. The four-story building is 1180 ft long and 365 ft wide, with a volume of 36 million cu ft.

The system normally will use gas heat, but will require some 500,000 gal of oil a year when gas is not available.

The $35 million center has a main theater seating more than 5000, a recital room, 23 meeting rooms, two restaurants, an art gallery, and an exhibit hall about the size of six football fields.

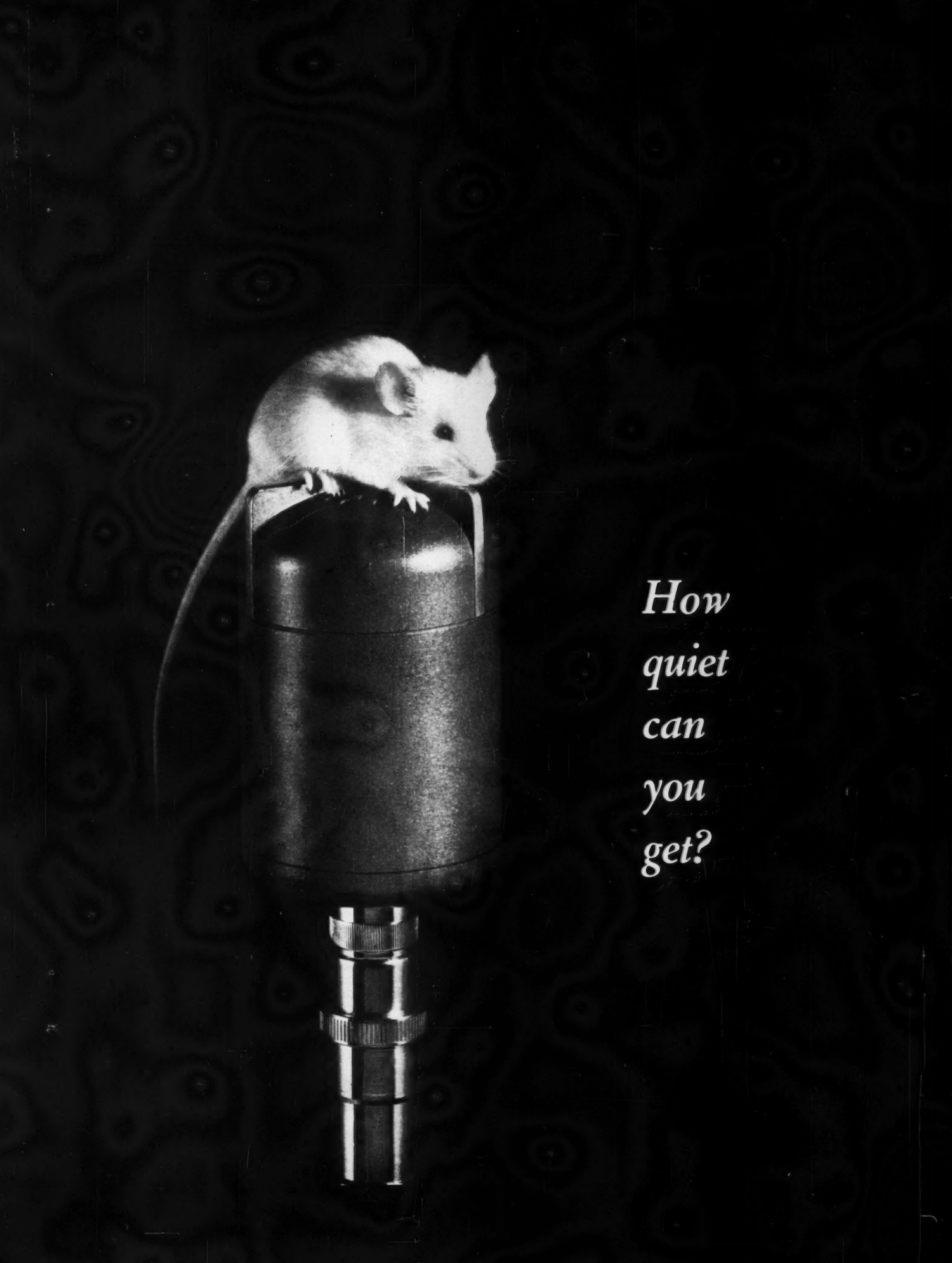
The first of a series of articles about the design and installation of the heating and air conditioning systems in this large project will be presented in an early issue.

## *Oldest Centrifugal Compressor Retired*

THE WORLD'S FIRST centrifugal compressor is ticketed to the Smithsonian Institution in Washington, D.C. for its inclusion in a new exhibit of air conditioning and refrigeration equipment to be unveiled next year.

The unit has recently been retired after 38 years of service. It was developed by Dr. Willis H. Carrier in 1922.

Carrier Air Conditioning Co. officials present at the shipping ceremonies were: John F. Kooistra, executive sales assistant; Russell Gray, president; Rose Marie Stasko, secretary; and Logan L. Lewis, a company founder.


How
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can
you
get?

# When you get ILG

# you can count

***Even this supersensitive mike*** has to "listen" hard to pick up sound waves from this smooth, silent-running, self-cooled Ilg propeller fan.

Direct-connected rather than belt-driven motors and fans account for some of the silence—but only part of it. More important are Ilg fan design and the Ilg quality control checks that cut down noise and vibration on all Ilg electric fans and ventilators.

Careful dynamic balancing of all component parts, and electronic checks of motor and fan wheels—both before and after final assembly—make sure that quiet operation is as much a part

***"Check-Out" Time.*** Every Ilg-built Type "Q" propeller fan wheel must pass rigid dynamic balancing "checks" before being direct-connected to Ilg-built *self-cooled,* 3-phase or permanent-split capacitor, single-phase motors. Ilg fans combine the cost operating advantages of *open type* motors with the protection of *totally enclosed* motors. New Catalog DB1-100 shows why. Why not send for it?

## For fans built to satisfy your "specs"...

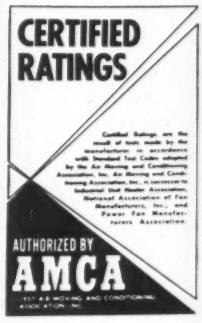
# fans and ventilators,

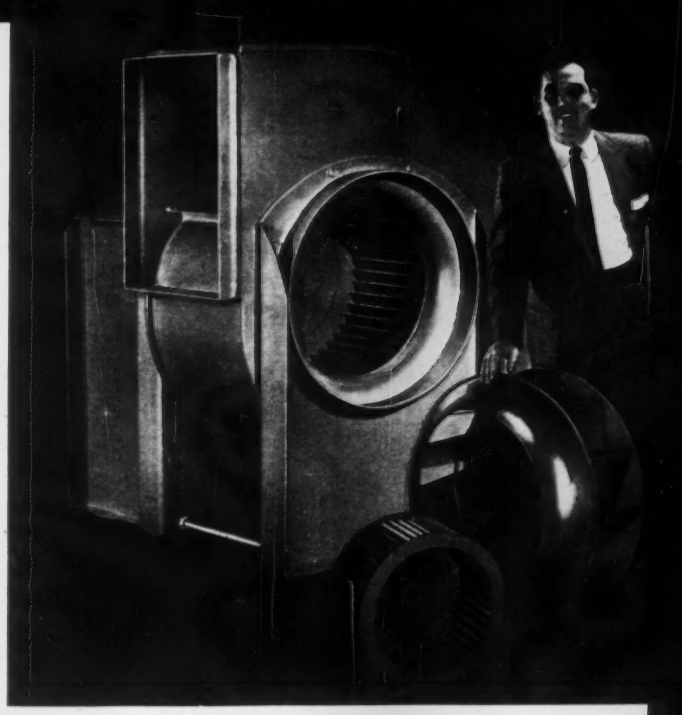
# on quiet operation

of each piece of Ilg equipment as the famous "One-Name-Plate" pledge of superior performance.

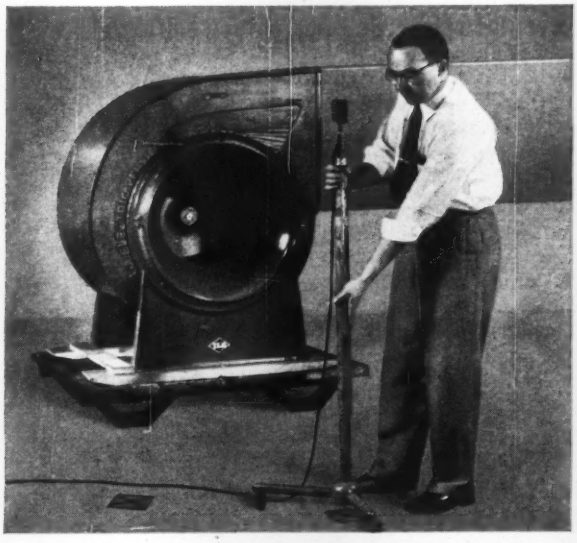
For further information, write for catalogs covering the complete line of Ilg electric ventilating equipment.

Each Ilg product shown carries the rating seal of the Air Moving and Conditioning Association Inc.



***Your Choice of Util-A-Sets.*** Twelve sizes of this new self-contained, belt-driven centrifugal fan to choose from, ranging in capacities from 688 to 23,000 c.f.m. Both forward curved wheels and backward blade types available. Motor mounting on rubber isolation rails checks resonant noise. Full line of accessories. See Catalog 3401.



***"X Marks the Spot"*** where the traveling mike is set to pick up sound waves from Ilg BC *airfoil* centrifugals. Backward curved airfoil blade design eliminates eddy currents and turbulence. Sound tests prove these fans can run at greater speed than older types—with *no increase in sound level, less drag and shock loss.* Standard construction suitable for Class I, II and III operation to 9" static pressure. See Catalog 257.

***Pinpointing Patented Pressure Cooling.*** Ilg fanwheel backplate fins draw a steady stream of clean, cooling outside air through motor compartment . . . protect motor against build-up of heat from sun . . . increase motor life expectancy up to 4 times that of ordinary units. For further facts on Ilg L-CRF direct-connected *airfoil* centrifugal roof ventilators, Send for Catalog 2701. And for LSQ propeller fan roof ventilators, write for Catalog 2302.

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**2826 N. Pulaski Road, Chicago 41, Illinois**
**Offices in 60 Principal Cities**

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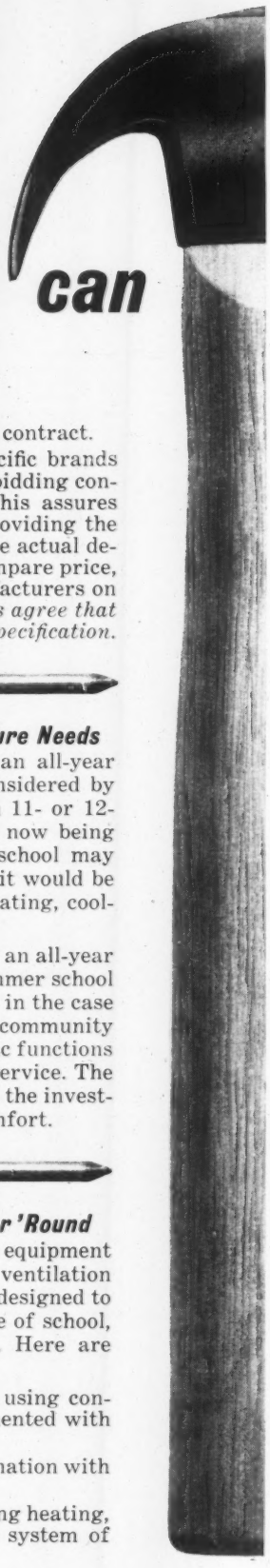
***When you plan to build a school...*** *let the application specialist from your local gas company help you, your architect and consulting engineer choose the most efficient system for heating, cooling and ventilating. Below you'll see how modern gas equipment can give your school complete classroom comfort—at reasonable cost.*

# How your GAS company can



***1. The Planning Team*** Right from the beginning, when you have chosen the architect for your new school, you realize that your project calls for a lot of teamwork—particularly in the design for efficient heating, cooling and ventilating systems.

A great help at this stage . . . for school management, architect and engineer alike... is the counsel of your local Gas Company regarding the economy and application of modern gas equipment for these systems.

Heating, cooling and ventilating facilities in many of the largest, most modern schools have been planned with the help of local Gas Companies' application specialists.

You can take advantage of this qualified help by setting up a very effective Planning Team: School Management—Architect—Engineer—Gas Company.

***2. The Complexity of Specification Writing*** Your architect's and engineer's knowledge of specification writing plays a major role in increasing the value of your school and keeping costs at a minimum. But *your* acquaintance with this vital function of school planning can be of assistance to them.

There are four major recognized methods of specifying materials and equipment for new building projects, such as your new school:

***a.*** The "Descriptive" Specification. Materials and equipment are described in detail, but no brands specified. Time may be lost in seeking the exact equipment described, and there is little assurance of quality.

***b.*** The "Flat" Specification. Exact brand is specified. No substitutes allowed. No protection against high costs.

***c.*** The "Open" or "Or Equal" Specification. Several makes are named, or the specification describing the required equipment includes an "or equal" clause. Contractor must submit his lowest bid regardless of quality. Manufacturers may hesitate to bid their lowest prices, since contractor is free to "shop" for even lower prices (to his advantage) after he is awarded the contract.

***d.*** "Base Bid With Alternate." Specific brands are specified for the base bid, but a bidding contractor may propose substitutes. This assures quality and permits alternatives, providing the contractor states in his bid to you the actual deduction or addition. You can then compare price, quality and service of several manufacturers on an equitable basis. *School authorities agree that this is the most acceptable type of specification.*

***3. Specifying for Present and Future Needs*** You may not plan now to operate an all-year school. But this subject is being considered by many school authorities. In fact, an 11- or 12-month school has been tried and is now being used. If there's a possibility your school may change to this system in the future, it would be wise to plan *now* for year 'round heating, cooling and ventilation.

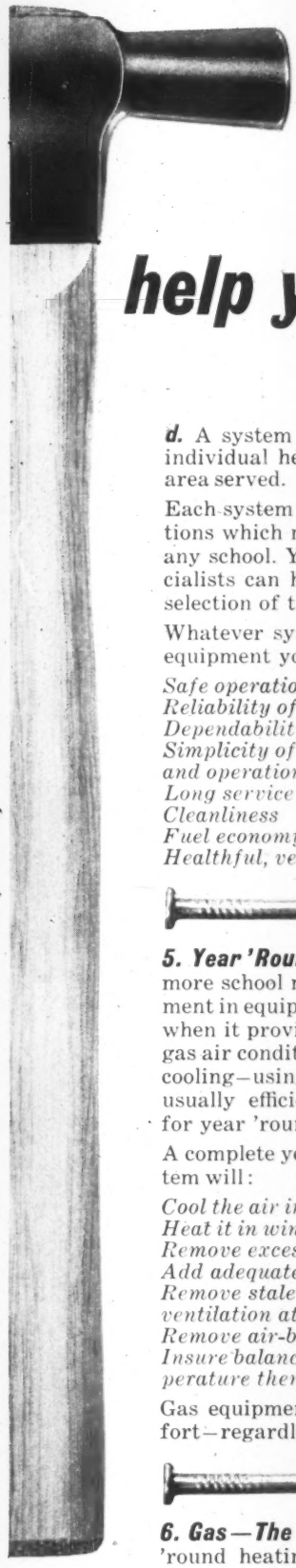
Even your *present* needs may call for an all-year operation, with such activities as summer school programs (including "make-ups" or, in the case of gifted children, "speed-ups")... community recreation... adult education... civic functions ... or perhaps a community library service. The success of such projects is well worth the investment in facilities for year 'round comfort.

***4. Wide Choice of Systems for Year 'Round Comfort*** The makers of modern gas equipment for year 'round heating, cooling and ventilation offer an unusual variety of systems—designed to meet the needs of every type and size of school, regardless of geographical location. Here are some of the choices:

***a.*** A conventional hot water system using convectors or radiators, usually supplemented with exhaust fans for ventilation.

***b.*** Radiant gas heating used in combination with a ventilating system.

***c.*** A central or zoned system combining heating, cooling and ventilating in the same system of ducts.



# help you build a better school

***d.*** A system such as the unit ventilator, using individual heating and ventilating units in the area served.

Each system has its own advantages and limitations which must be considered in the plans for any school. Your Gas Company application specialists can help you and your architect in the selection of the proper system.

Whatever system you choose, with modern gas equipment you can be sure of:

*Safe operation*
*Reliability of equipment*
*Dependability of energy source*
*Simplicity of installation, maintenance and operation*
*Long service life*
*Cleanliness*
*Fuel economy*
*Healthful, ventilated air*

***5. Year 'Round Gas Air Conditioning*** More and more school managements agree that an investment in equipment to condition air is worth more when it provides year 'round service. And since gas air conditioning systems deliver heating *and* cooling—using the same basic fuel—they are unusually efficient, economical and space-saving for year 'round operation.

A complete year 'round gas air conditioning system will:

*Cool the air in summer*
*Heat it in winter*
*Remove excess moisture in summer*
*Add adequate moisture in winter*
*Remove stale air and provide effective fresh air ventilation at all times*
*Remove air-borne dirt*
*Insure balanced distribution of the air, with temperature thermostatically controlled.*

Gas equipment offers complete classroom comfort—regardless of weather or season.

***6. Gas—The Economy Fuel*** For modern year 'round heating and cooling systems, no other fuel matches the long-run economy of gas. Fuel costs—as opposed to first costs—will continue for the life of your school. So they deserve serious consideration in your original planning. As a matter of record, many schools have amortized the first cost of their gas equipment through comparative savings on fuel. Thrifty gas keeps your operating costs down all year, every year.

***7. Gas—The Safest Fuel*** The gas industry has a prime interest in the safety of your pupils. The more than 200,000 people in the gas industry—most of them with children of their own—have seen to the security of each installation.

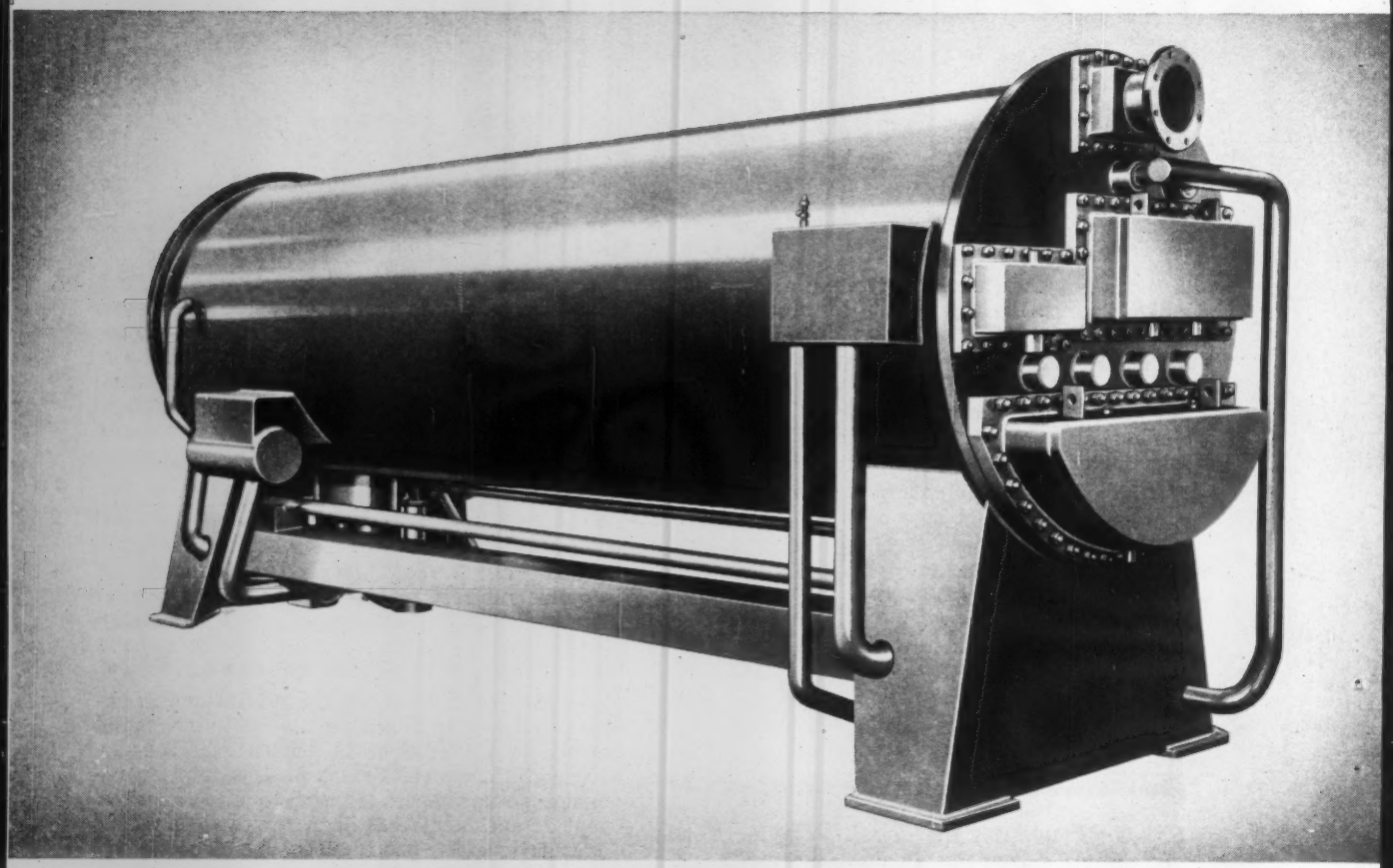
No other industry in the United States has encouraged such rigid self-regulation to insure the safety of its product in homes and schools. Through the American Gas Association Laboratories, gas equipment is tested to meet the stringent requirements of the American Standards Association. The gas industry has drafted safe installation methods which are practiced by every Gas Company in the country.

Most important, the gas industry has cooperated with municipal authorities to have your building codes reflect the most up-to-date practices regarding the safe installation and safe operation of gas equipment.

***8. Gas—For Complete Classroom Comfort All Year Long*** Your pupils can learn more – your teachers can teach more effectively – in more comfortable surroundings. Let your Gas Company help you and your architect choose the most efficient system for heating, cooling and ventilating. Just call your Gas Company and ask for their Application Specialist.
*American Gas Association.*

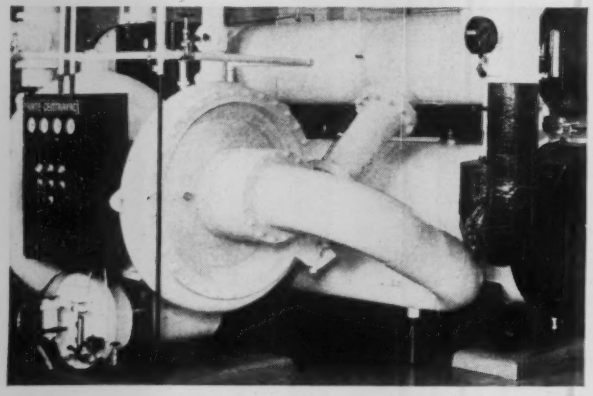
***FOR COMPLETE CLASSROOM COMFORT***
***HEAT AND COOL WITH GAS***

# Now! Low-cost industrial Trane Hermetic

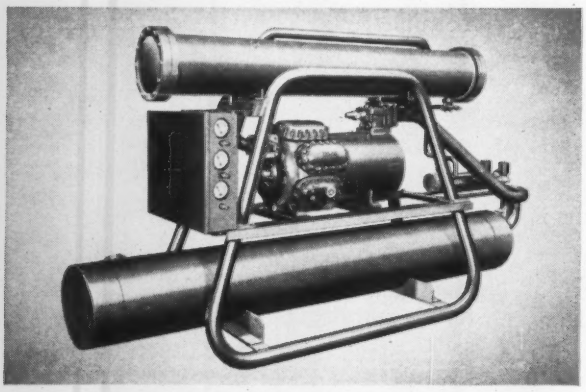


For industrial process cooling or comfort air conditioning—wherever there is a supply of low-cost steam—the new TRANE Absorption Cold Generator is available in twelve sizes, 100 to 530 tons . . . making it easy to select a unit to match the exact requirements; means fuel savings and efficient part load operation.

## There's Trane matched equipment for every air conditioning need...



**Hermetic CenTraVac** water chiller with electric drive modulates to 10% of capacity, or lower, with power savings in almost direct proportion to load. Compact, with low silhouette design. Open type compressor models for any type of drive and steam turbine CenTraVacs are available.



**New Reciprocating Cold Generator now hermetic**—with TRANE built chiller and condenser. Provides efficient water chilling for a wide variety of applications. Factory-wired control panels mounted on unit to eliminate on-the-job wiring. Features new TRANE Hermetic Reciprocating Compressor.

# water chilling...with a Absorption Cold Generator

*Advanced hermetic design, single-shell construction provide simplified installation, minimum maintenance, economical operation for process or comfort cooling*

Here's a compact packaged hermetic absorption water chiller—the TRANE Absorption Cold Generator. It's designed to provide a dependable, economical source of chilled water for process or comfort cooling in industrial plants, hotels, apartments and office buildings—wherever there is a supply of steam or hot water.

The advanced *hermetic* design assures reliable operation under all operating conditions . . . prevents air from entering the system which causes crystallization, deterioration and maintenance problems. The machine operates under conditions which avoid crystallization. (If power failure or other temporarily abnormal conditions occur, the machine will tend to free itself of any resulting crystallization.)

Fully automatic operation means no full time attendant is needed. The unit responds immediately and automatically to changing load requirements. Its design provides maximum efficiency under full and partial load conditions—results in low power consumption, economical operation. And the new Absorption Cold Generator is *quiet*, vibration-free—may be located anywhere without sound-proofing the area. Single-shell construction reduces overall size, permits installation in areas with low ceilings. Factory-assembled and wired, it has been designed to effect substantial savings in installation time and costs. Twelve sizes from 100 to 530 tons permit selection of a unit to match the exact cooling requirements.

The TRANE Company has extensively tested and proven this new *hermetic* absorption water chiller design assuring dependable, economical water or other liquid chilling for a wide variety of applications; and it will minimize operation and maintenance problems.

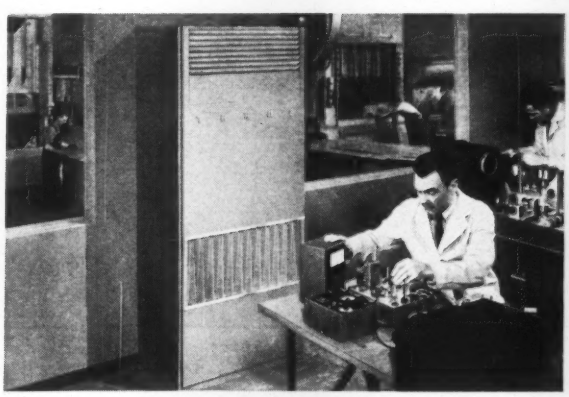
**WANT MORE FACTS?** For complete information on the new TRANE Hermetic Absorption Cold Generator, just call your nearby TRANE Sales Office; or write TRANE, La Crosse, Wisconsin.

***For any air condition, turn to***

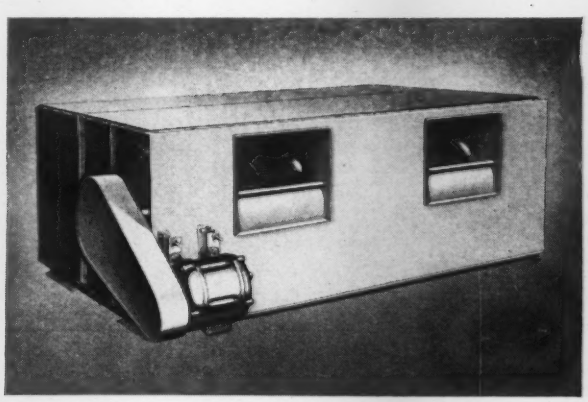
# TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 100 U. S. AND 19 CANADIAN OFFICES



**New Heat Pump** is compact, efficient, designed for in-the-room or remote installation. 3 to 15-ton capacities for industrial or commercial applications. Easily accessible piping and connections simplify installation. Compact water to air unit takes little floor space. Refrigeration cycle removable.



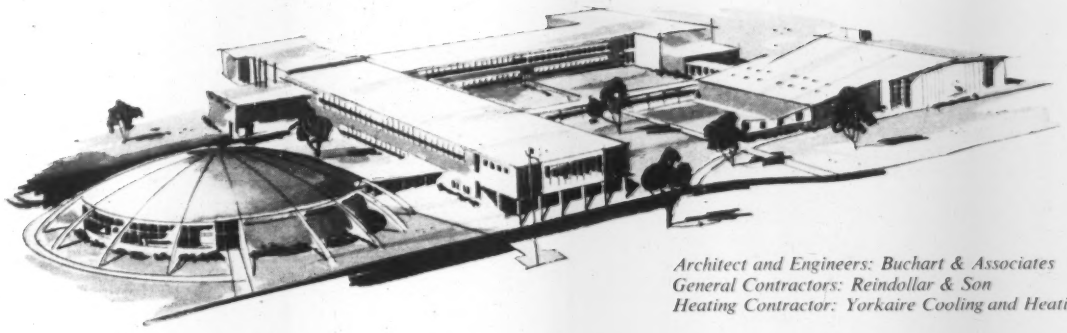
**New Climate Changers heat, cool,** ventilate . . . solve a wide variety of application problems. Single-zone and multi-zone units that supply different air conditions for as many as 14 zones at the same time. New design features reduce overall costs. 1200 to 47,000 cfm.

**Mr. Curtis A. Botts—heating and ventilating contractor for the new Hannah Penn Junior High School, York, Pa., says:**

# "Working with Honeywell, and finished

Mr. Curtis A. Botts, President of the Yorkaire Cooling and Heating Company, in one of the Honeywell-controlled classrooms at Hannah Penn Junior High School. For excellency of design, this beautiful new school was awarded a certificate of merit by the American Society of Registered Architects.

# we started the job on time."



*Architect and Engineers: Buchart & Associates*
*General Contractors: Reindollar & Son*
*Heating Contractor: Yorkaire Cooling and Heating Co.*

**Trained Honeywell specialists helped keep Hannah Penn school on schedule, supervising the temperature control system during planning, installation and checkout.**

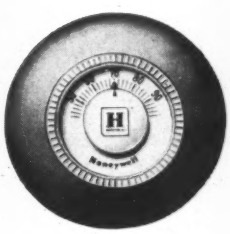
"Honeywell's trained specialists helped us avoid costly delays," says Mr. Botts. "They turned in clear shop drawings of the temperature control system. They helped speed up equipment deliveries. They gave us good supervision during installation, then checked out the entire system. As a result, we started on time, and *stayed* on time until the job was finished."

The result for this handsome new school is an efficient, smooth-working temperature control system with wall-mounted classroom thermostats—a system that assures an indoor climate ideal for better teaching, better learning.

If your next job calls for a temperature control system by Honeywell, you'll get all the help you need from skilled, efficient specialists—help that saves you money, time and worry. Get the whole story; call one of the 112 Honeywell sales and service offices nearest you. Or write Honeywell, Dept. AC-12-75. Minneapolis 8, Minn.

**Honeywell**

H HONEYWELL *First in Control* SINCE 1885



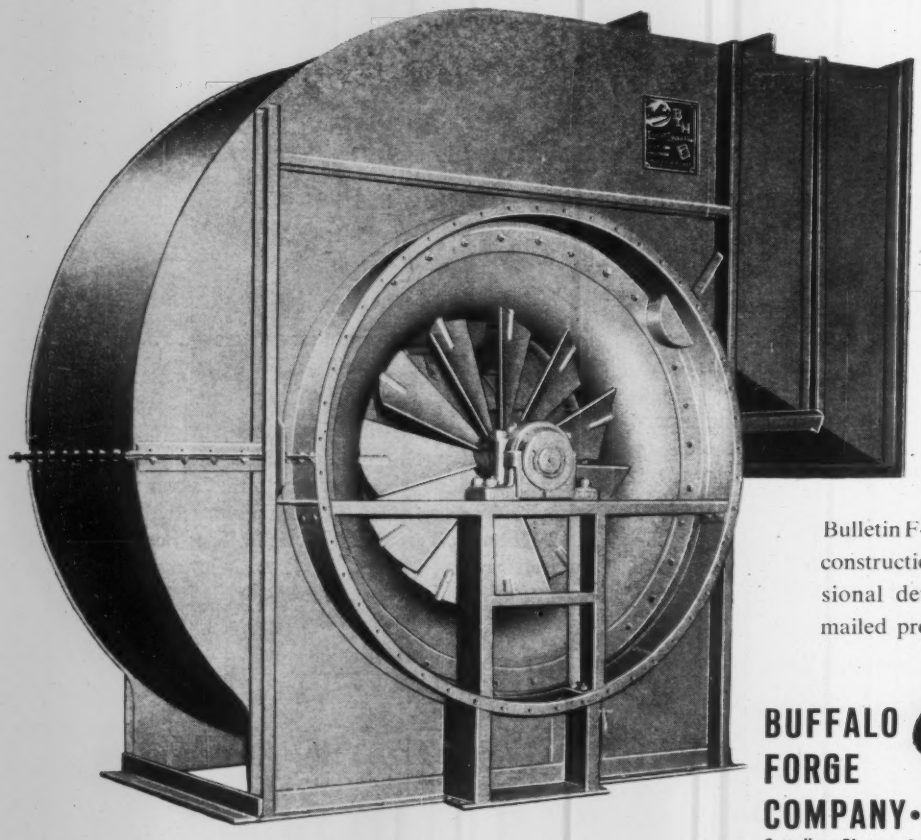
The Honeywell Round Thermostat—famous symbol of quality temperature control

75TH YEAR PIONEERING THE FUTURE

# BLH-
# EFFICIENT AIR MOVER FOR YOUR
## HIGH PRESSURE SYSTEMS

Since the finest air conditioning system available is no better than the fan that powers it, the Buffalo Type BLH Fan merits your most serious consideration.

The BLH is a better fan for your high-pressure system. It's a heavy-duty fan for Classes III and IV service. It offers the highest efficiency over the broadest range. In addition to the quietest, smoothest air ride from inlet to outlet (thanks to curved inlet bell, inlet guide vanes, inlet wheel flange matching the curved inlet bell, backward curve blades and graduated housing) it has the unique Buffalo divergent outlet providing smooth outlet flow and high static regain. For efficiency at high pressures, the BLH is without equal — and for dampered operation, Buffalo Variable Inlet Vanes can be substituted with less than 1 percent reduction in catalog rating; performance that cannot be equalled by conventional variable vane design.



Bulletin F-200 contains performance, construction, capacity and dimensional details. Your copy will be mailed promptly on request.

**BUFFALO FORGE COMPANY** • **BUFFALO, NEW YORK**

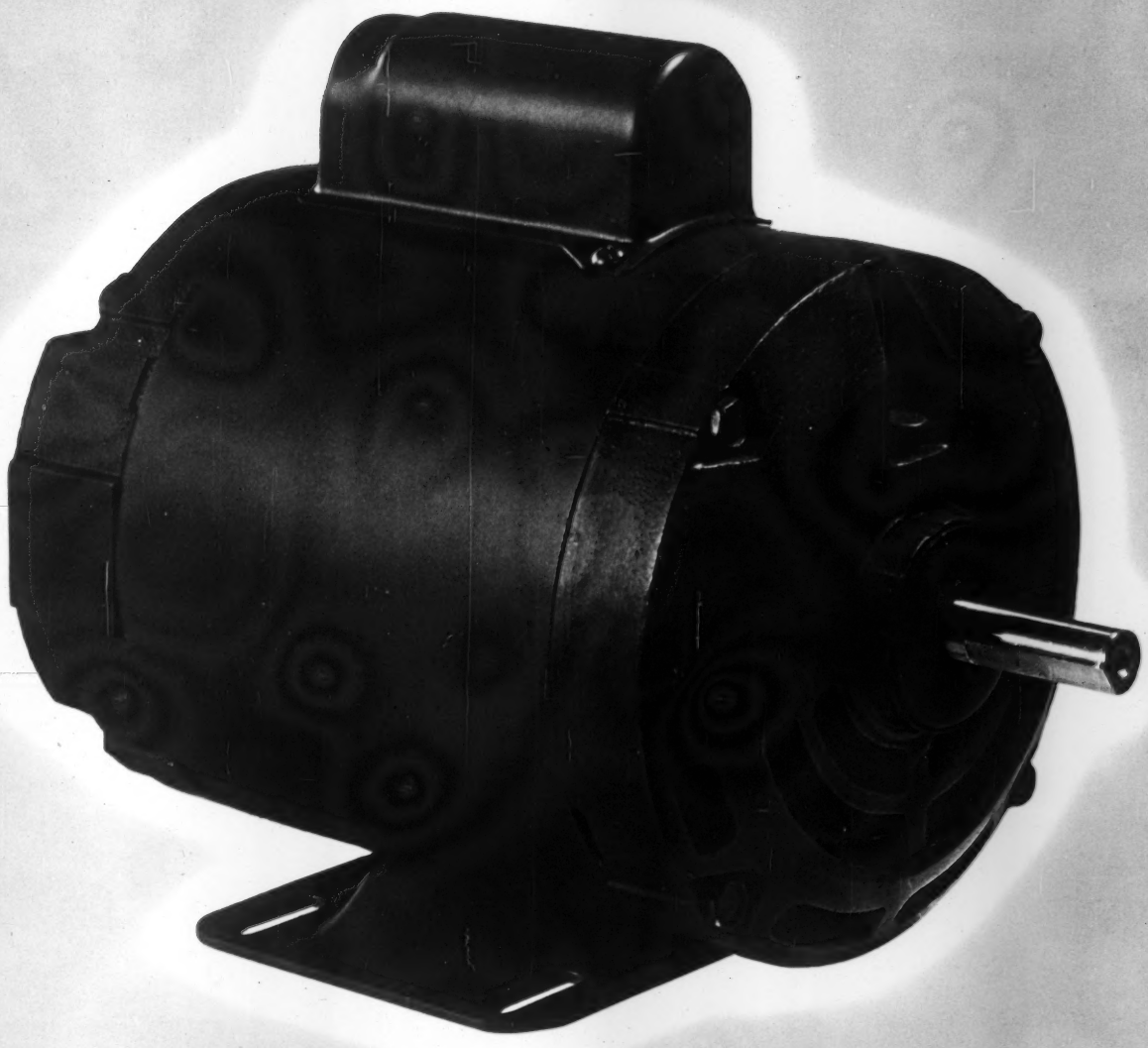
**Canadian Blower & Forge Co., Ltd., Kitchener, Ont.**

*Buffalo air handling equipment to move, heat, cool, dehumidify and clean air and other gases.*

*Buffalo Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.*

*Buffalo Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.*

*Squier machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.*



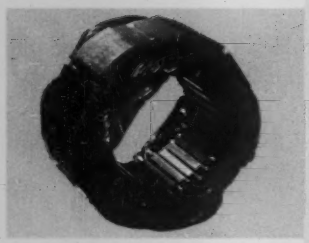
# A NEW Duty Master FHP.

## for heavy-duty industrial use

**RELIANCE** ELECTRIC AND ENGINEERING COMPANY

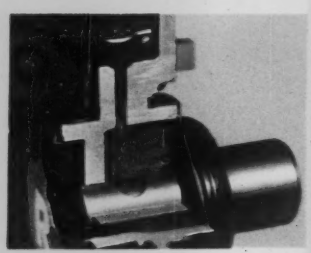
**MASTER** ELECTRIC COMPANY DIVISION

# A NEW Duty Master FHP.

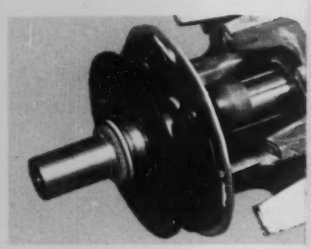


PROTECTED STATOR

TERMINAL BOARD



SLEEVE BEARING



CENTRIFUGAL CUT-OUT

## A motor that combines new, most-wanted features at no extra cost

**This motor is tough all over** . . . deliberately designed for heavy industrial duty. Frame is rolled from steel—end shields cast from an aluminum alloy specifically selected for strength. Ball bearings are double-shielded, with lubricant packed into the bearing for life. Sleeve bearings are steel-backed and babbitt-lined for low friction and long wear. "Permawick" oil retaining material provides maximum lubrication to these bearings. Rotor is pressure-cast from high purity, low-resistance aluminum. Varnish impregnated stator resists moisture . . . and adds strength to windings.

**More power per pound . . . simple installation,** 33% lighter than other preceding motor designs. Good design and materials make the difference. Makers of motor-driven products save on shipping and handling costs. Duty Master's light weight and small size make possible lighter, less complex mounting on equipment. Terminal board provides easy power connection in the front end shield. Cover plate quickly removable. Motor rotation easily reversed by interchanging slip-on connections.

**Up to 10% cooler than other comparably rated motors** . . . yet gives you maximum protection. High load capacity results from new, effective ventilation of critical heat sources. Laminations, coils and rotor are literally rinsed with cooling air through new end shield design. In totally-enclosed, non-ventilated motors, the fan, cast integrally with rotor, circulates the air within the motor at a rate appropriate to efficient transfer of heat to motor frame and end shield. And load carrying capacity of the totally-enclosed fan-cooled motor is increased by a fan and shroud directing air over the frame and end shield.

**Quiet . . . Smooth . . . Positive.** Resilient mounting composed of metal-rimmed, rubber-cushioning rings that encircle the bearing hubs on each end and support the motor. Motor can be mounted in any position. Single phase starter winding circuit automatically opens at 80% of full load speed. Action is quiet and positive.

Available now in 48 and 56 frame sizes, from conveniently located stocks. Duty Master FHP. is made in 1/8, 1/6, 1/4, 1/3, 1/2 and 3/4 hp. capacitor-start, split-phase and polyphase for 48 and 56 frames; repulsion-start induction-run in 56 frame. Your Reliance Sales Engineer or Distributor has all the facts at his finger tips. Call him or write for Bulletin B-2514. It will be sent to you promptly. B-1675

PRINTED IN U.S.A.

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

CLEVELAND 17, OHIO

Canadian Division: Toronto, Ontario

Sales Offices and Distributors in principal cities

Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

Office and shop J. E. Rimel Plumbing Company, Kansas City, Missouri. Heating installed by owner.

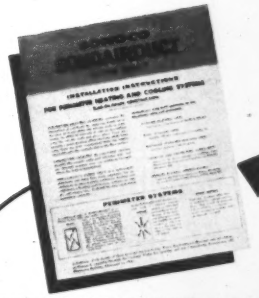
# THE **DEPENDABLE** FIBRE DUCT
## that's easier to install

In slab perimeter heating and cooling, do you want to hold down costs while maintaining high quality? Do you want dependability you can count on, in a system that's easily and quickly installed? Then you want SONOAIRDUCT Fibre Duct for your next slab perimeter job!

Year after year, SONOAIRDUCT has been America's best selling Fibre Duct – proving its dependability in thousands of installations. And, aluminum foil-lined SONOAIRDUCT meets or exceeds *all* F.H.A. criteria and test requirements for products in this category.

This low-cost, lightweight fibre duct saves you time, labor and money too! Easy-handling SONOAIRDUCT joins and levels quickly . . . can be cut to length or mitered with a hand saw. There are no sharp edges, and it won't chip, crack or break when dropped – every piece is usable!

To protect your reputation, your profit margin, *and* the interests of your customers, always install Sonoco SONOAIRDUCT – the BEST in Fibre Duct. Available in 23 sizes, 2" to 36" I. D., standard 18' lengths. Special sizes to order.



**FREE INSTALLATION MANUAL**
Contains latest, detailed, step-by-step installation data for SONOAIRDUCT Fibre Duct. For free copy, send us your name and address on company letterhead.

5190

*For complete information, see our catalog in Sweet's or write*

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Construction Products

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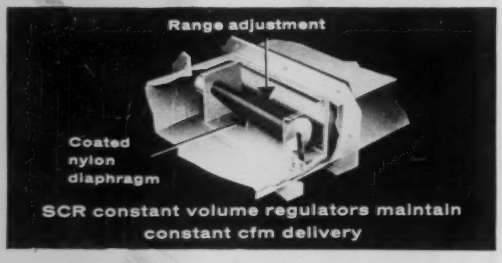
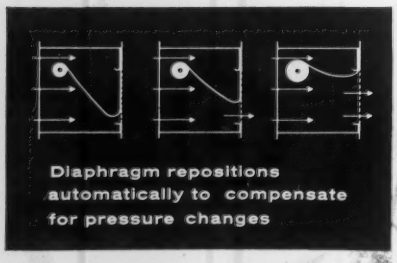
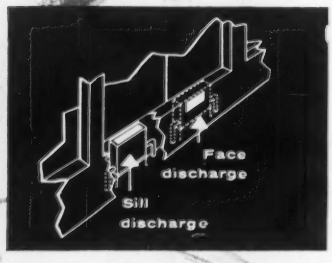
# How to harness high




SCR constant volume regulators maintain constant cfm delivery



Diaphragm repositions automatically to compensate for pressure changes



# velocity air

High velocity air distribution has won its spurs. Its growing use is a reflection of the important space and material costsavings which it makes possible in new construction — plus the flexibility and cost-reducing simplification which the smaller duct sizes bring about on modernization jobs.

At the same time, high velocity systems have confronted engineers with new requirements in system design and stabilization, as well as in selection and application of air distribution equipment. The problems are different than in conventional systems, but they need not be more difficult.

For over ten years Barber-Colman has conducted extensive research, testing, and development work on high velocity systems — with a resultant wealth of valuable data, plus important new high velocity air distribution products.

Barber-Colman air valves and constant volume regulators greatly simplify the design and stabilization of systems. They provide accurate, dependable means for reducing high velocities to conventional velocities, controlling hot and cold air mixing, and maintaining constant cfm delivery.

For real help on high velocity, ask for Barber-Colman's 52-page High Velocity Data File.

See our exhibit
Booth No. 506-508
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Air-Conditioning Exposition
Chicago, Feb. 13-16.

Single- and double-duct control units for under-window installation — sill or front discharge

BARBER COLMAN

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Dept. L, 1101 Rock Street, Rockford, Illinois

## It's the Industry's Target and should be yours, too

# to SEE, LEARN, COMPARE **WHAT'S NEW** in HEATING · REFRIGERATION AIR CONDITIONING · VENTILATION

**SEE** on display the newest in product developments that the industry has to offer for indoor climate control, covering domestic, commercial and industrial applications.

**LEARN** from the top executives, engineers and salesmen, how their products can best be applied to meet your specific requirements.

**COMPARE** what you see and learn from the more than 500 manufacturers participating in the exhibition—what better way to find the product or system that best suits your company's needs?

There is no other way in which so much useful information on new developments can be obtained—in such a limited period of time—than through a visit to the more than 500 fact-filled displays covering all phases of heating, refrigeration, air-conditioning and ventilation.

## *15th* INTERNATIONAL HEATING & AIR CONDITIONING EXPOSITION

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**INTERNATIONAL AMPHITHEATRE, CHICAGO, FEB. 13-16, 1961**

Management: International Exposition Company

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Air-Conditioning units and systems, Boilers, Burners, Fans, Blowers, Bearings, Condensers, Compressors, Controls, Coolers, Fittings, Filters, Exhausters, Heat Exchangers, Dehumidifiers, Pipe Tools, Pumps, Preheaters, Motors, Meters, Piping, Valves, Hose, Heaters—Coal, Electric, Gas, and Oil, Furnaces, Grilles, Hangers, Gages, Ventilators, Water-Treatment, Tubing, Traps, Cooling Zoners, Thermostats, Thermometers, Switches, Separators, Regulators, Refrigerants, etc.

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**Chancery of the Embassy of Switzerland,** *where gas provides heat for comfort through a Lo-Blast Burner.*

**National Rifle Association of America.** *New building is heated throughout with Lo-Blast Gas Burners, installed on the roof to save valuable space.*

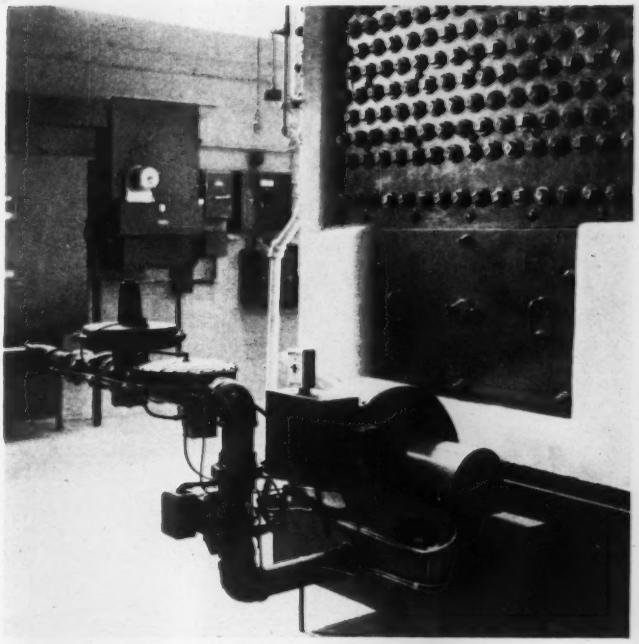
# In Washington, D.C....cost-conscious building

Private homes, clubs, schools, government buildings, industrial plants...all types and sizes of buildings in Washington...get top heating efficiency and unbeatable fuel economy with Lo-Blast Power Gas Burners. Consistently low operating costs reflect the advantages of this type of burner.

Versatile Lo-Blast burners adapt easily to any boiler or furnace. With their "inshot" design, all components are outside the firebox for easy access and longer life. Burners operate automatically with forced air injection, independently of variable chimney drafts. You get greater combustion efficiency with all the conveniences and economy of gas heat. For information on Lo-Blast Gas Burners—and their smaller counterpart, the Economite—contact your local Gas Company, or write to Mid-Continent Metal Products Co., 1960 N. Clybourn Ave., Chicago 14, Illinois. *American Gas Association.*

**St. Anthony's High School.** *The Lo-Blast Gas Burner keeps the entire building comfortably warm, from classrooms to the spacious gymnasium.*

*Economite and Lo-Blast Power Gas Burners operate silently, cost less to install, are well suited for down-draft boilers, and are available in capacities from 70,000 to 20,000,000 BTU.*



# owners heat with LO-BLAST GAS burners

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**FOR HEATING GAS IS GOOD BUSINESS!**

This mark tells you a product is made of modern, dependable Steel.

## "We've been buying from National Tube Distributors for almost 25 years—and they've never let us down."

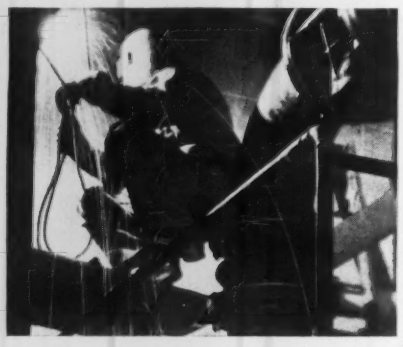
So says Mr. Stanley Carter, President, Stanley-Carter Company, Mechanical Contractors, Detroit, Michigan. *"Good distributor service is tremendously important to our profit margin. That's why we've been working with National Tube Distributors as long as we have.*

*"We've never had a single project held up because of a late delivery from a National Tube Distributor—men and equipment tie-ups because of late shipments can waste a lot of money."*

*"We kept a big job right on schedule in Nashville, Tennessee, when the USS National Pipe arrived exactly at the time they promised it.*

*"It looked like we were headed for trouble on a big Detroit job this year. We needed a lot of pipe in a hurry. All it took was a few phone calls. We received the pipe within 24 hours."*

*"National Tube salesmen and distributors back us with technical assistance. They not only keep us abreast of changes in specifications but offer recommendations if specifications need to be changed."*



*"On this job, the distributor worked with the architect when a spec change was needed—the new specification was just as good for this particular job, and it saved us serious delays.*

*"A National Tube salesman helped recommend a specification equal to the original spec but for a less expensive material on a plant expansion job we were doing. Cut the cost about 10%."*

*"Another thing we like. These National Tube Distributors carry a complete stock of pipe sizes.*

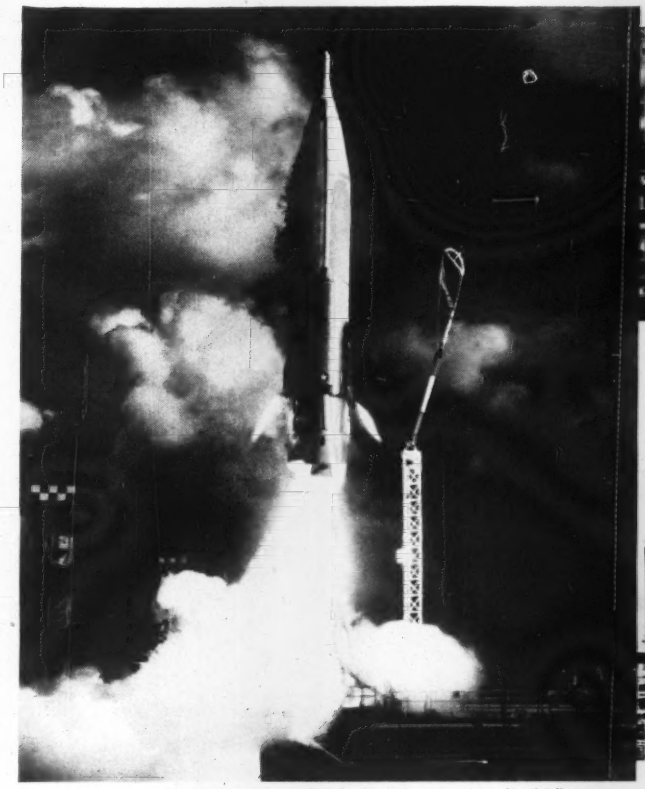
*"And the quality is excellent. In the past 20 years, we've had no trouble with USS National Pipe. If trouble were encountered, we know help is as close as our telephone. We can call our National Pipe Distributor or National Tube, and the team goes into action immediately."*

*USS and NATIONAL are registered trademarks*

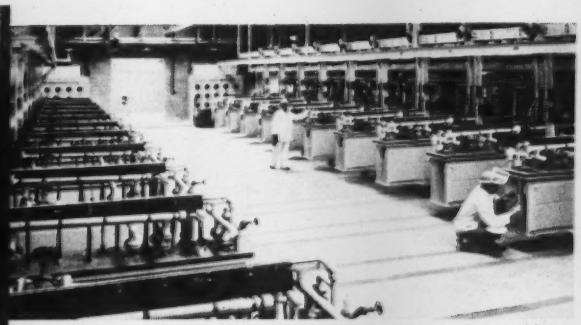
Watch United States Steel's special Christmas show, **The Coming of Christ,** in Color on NBC-TV, Wednesday, December 21, 8:30 P.M., E.S.T.

**National Tube Division of United States Steel**

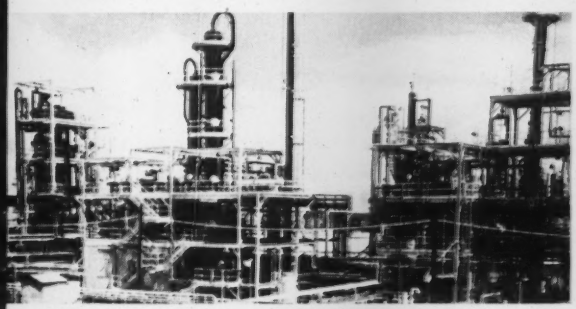
Columbia-Geneva Steel Division, San Francisco
Pacific Coast Distributors
United States Steel Export Company, New York



**Providing tremendous thrust,** new rocket fuel oxidizers such as liquid fluorine, chlorine trifluoride and other halogen fluorides may help us conquer space. Like "Genetron" fluorinated hydrocarbon refrigerants, they are important developments of General's long research in fluorine chemistry.



**Largest privately-owned fluorine producing facilities** in the world are located at General Chemical's Metropolis, Ill., Works. In these cells elemental fluorine is produced for use as a high-energy oxidizer of rocket fuels and for production of uranium hexafluoride for the Atomic Energy Commission. Allied Chemical's leadership in fluorine chemistry is applied to continuing improvement of "Genetron" refrigerants.



**This giant fluorochemical center** in Baton Rouge, La., makes many of the fluorine-based compounds required by industry and is a major production center for "Genetron" refrigerants. "Genetron" refrigerants are also manufactured in Danville, Illinois. Soon a new plant in Elizabeth, N. J., will provide a large new source for "Genetron" refrigerants.

# What do rockets have to do with genetron® super-dry refrigerants?

Just this. Part of the "big push" into outer space may come from fluorine-based propellants now being supplied by General Chemical to the nation's rocket and missile research centers. The same know-how that makes General Chemical the leader in fluorine chemistry applies equally in other areas—especially in the development and production of "Genetron" fluorinated hydrocarbon refrigerants.

Behind "Genetron" Super-Dry Refrigerants is a research organization which is internationally recognized for its work in fluorine chemistry. Even more important to every user of "Genetron" refrigerants are the Company's advanced manufacturing facilities, which have helped bring quality standards for fluorinated hydrocarbon refrigerants to new highs of purity and dryness—a major contribution in itself.

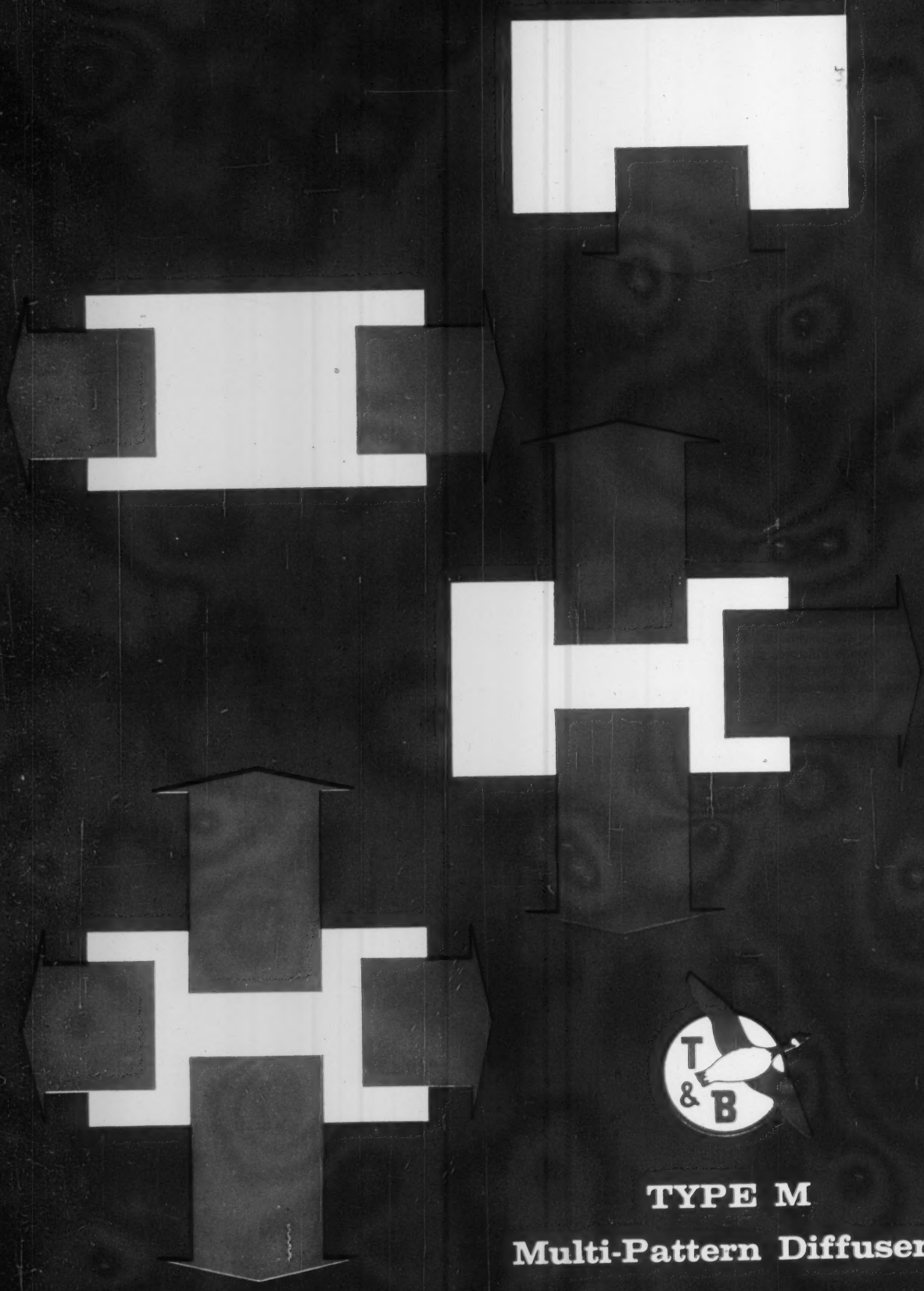
"Genetron" Refrigerants are approved, accepted, *preferred* because they are *performance-proved*. Refrigeration engineers, contractors and servicemen endorse them. Wholesalers recommend them.

It makes sense to rely on the leader in fluorine chemistry for fluorinated hydrocarbon refrigerants. Next time you order, insist on "Genetron" and be sure of the best! Available from wholesalers everywhere.

Allied Chemical

**GENERAL CHEMICAL DIVISION**
**40 Rector Street, New York 6, N. Y.**

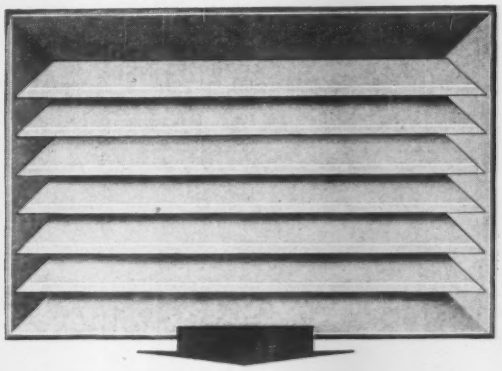
*Look to the leader in fluorine chemistry... insist on "Genetron."*



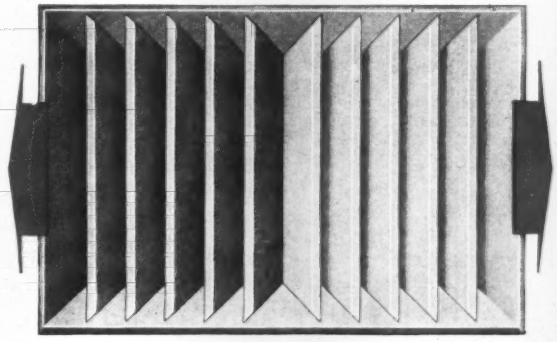
# TYPE M
## Multi-Pattern Diffusers

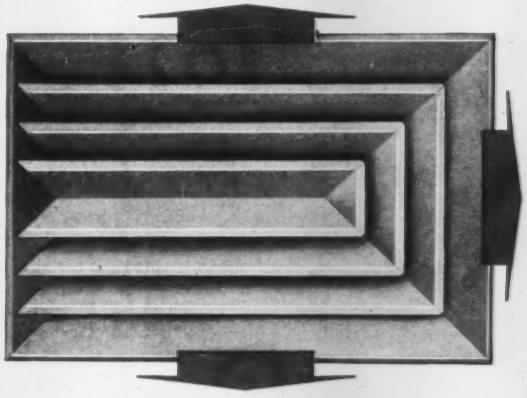
# *The extreme flexibility of*
# Type M Multi-Pattern Diffusers
# *means custom-selected air distribution*

TYPE M 1-WAY BLOW

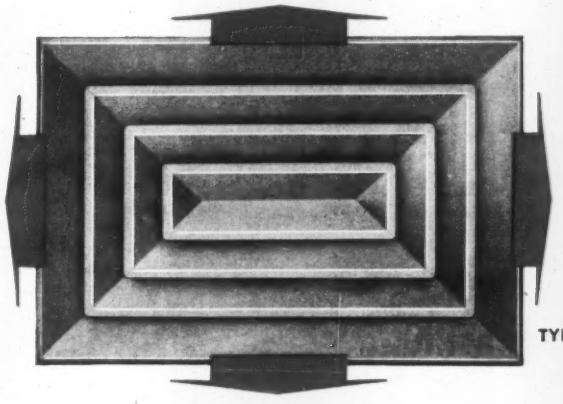


TYPE M 2-WAY BLOW





TYPE M 3-WAY BLOW



TYPE M 4-WAY BLOW

Ideal conditions for the placement of ceiling diffusers do not always exist. Walls, partitions, exposed beams, supporting columns, light fixtures . . . big offices, small offices, corridors . . . are some of the factors that can contribute to the problem of correctly selecting and locating air distribution outlets.

With Tuttle & Bailey Type M Diffusers . . . you can select units that will distribute air in a one-, two-, three-, or four-way pattern . . . and you can select from a wide range of square and rectangular sizes. An added advantage . . . if and when requirements change in the conditioned space, it is an easy matter to install a core with a different air pattern arrangement.

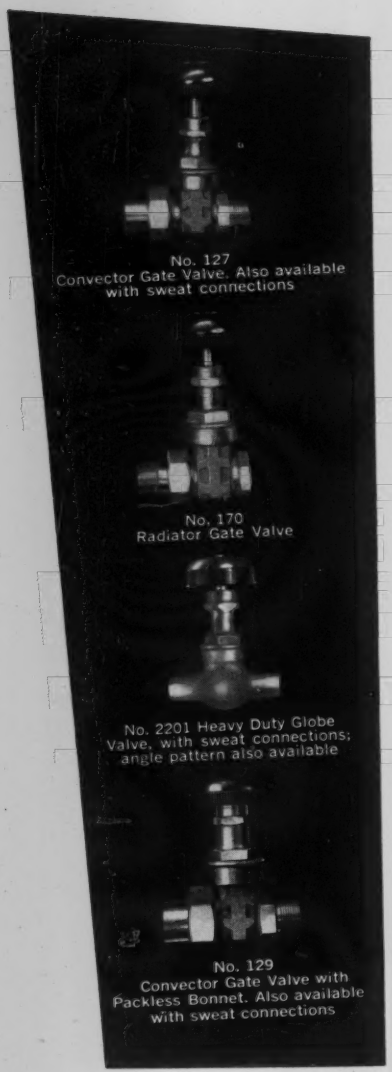
T & B Type M Diffusers are attractively styled and can be furnished with four margin styles . . . beveled, flat, flush, or drop-collar . . . designed for various types of ceiling mountings.

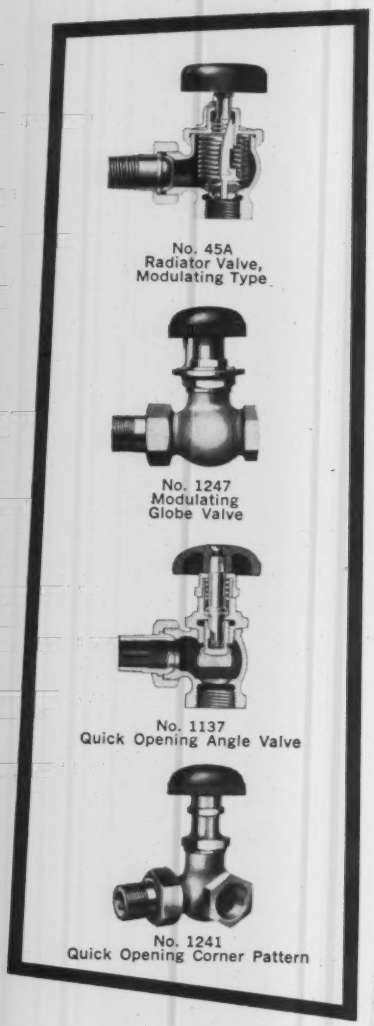
For complete details, see your nearest Tuttle & Bailey Representative or write us direct.

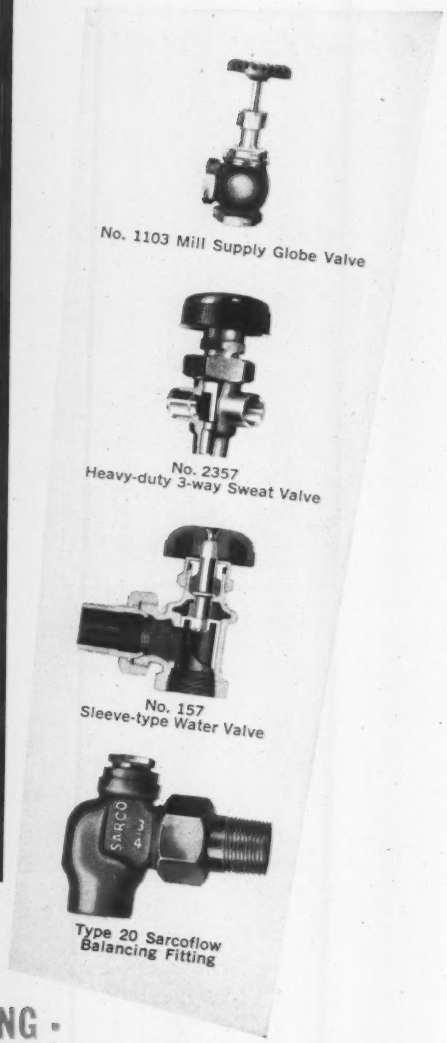
TUTTLE & BAILEY

division of Allied Thermal Corp. New Britain, Connecticut

Tuttle & Bailey Pacific, Incorporated, City of Industry, California


No. 127
Convector Gate Valve. Also available with sweat connections
No. 170
Radiator Gate Valve
No. 2201 Heavy Duty Globe Valve, with sweat connections; angle pattern also available
No. 129
Convector Gate Valve with Packless Bonnet. Also available with sweat connections




## FOR STEAM HEATING • RADIANT HEATING • HOT WATER HEATING • AIR CONDITIONING

# SARCO RADIATOR VALVES

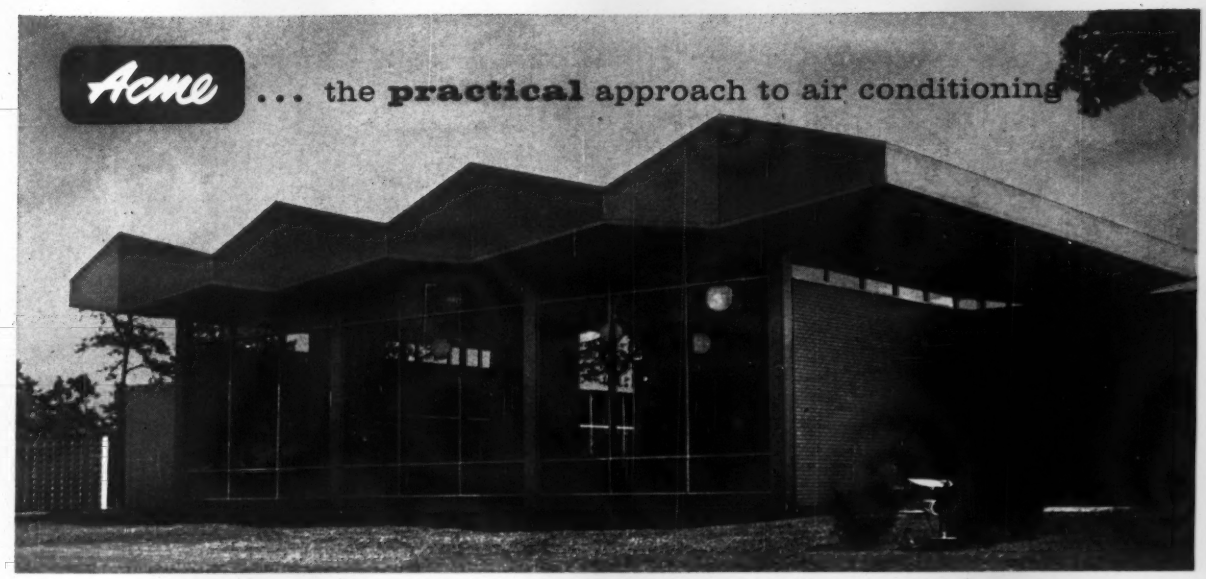
You can meet your most exacting needs in radiator valves with Sarco. For steam: Bellows-Packless, Spring-Packless, and Gland-Packed. For hot water: Spring-Packless and Gland-Packed. Made in globe and gate types, angle and corner patterns, modulating and quick opening. Sizes from ⅜″ to 2″, pressures up to 200 psi.

**WRITE FOR YOUR FREE COPY**

of the new Bulletin No. 225, covering radiator valves, balancing fittings, and access boxes, with sizes, capacities, and roughing-in dimensions.

SARCO

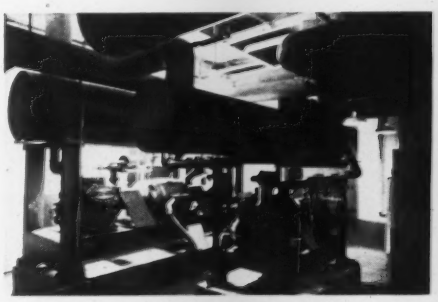
SARCO COMPANY, INC.
AN AFFILIATE OF SARCOTHERM CONTROLS, INC.
635 MADISON AVENUE, NEW YORK 22, N.Y.
PLANT: BETHLEHEM, PA.



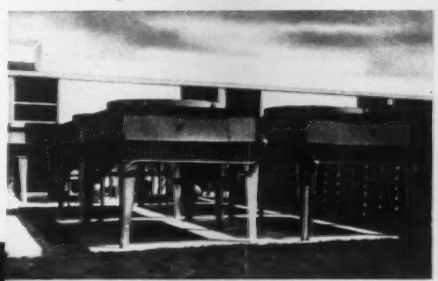

# Acme selected . . . results excellent

Architecturally, a "gem" . . . throughout, a model of modern office efficiency, beauty and comfort. That's the word on the new Atlantic City Electric Co. Accounting and Data Processing Center, Pleasantville, N. J. On the air conditioning system, the word is Acme, and according to H. C. Moore, Jr., of John H. Moore & Son, Mechanical Contractors, it's a very good word indeed. "The owners wanted a system, at a budget price, that would function quietly, efficiently, dependably . . . one that would be easy and economical to operate and maintain. Acme was selected and . . . thanks to the high quality and unsurpassed performance of Acme equipment . . . results have been excellent, the owners are completely satisfied."

Owners, architects, engineers and contractors, in growing numbers everywhere, are reporting complete satisfaction with Acme. May we number you among them?



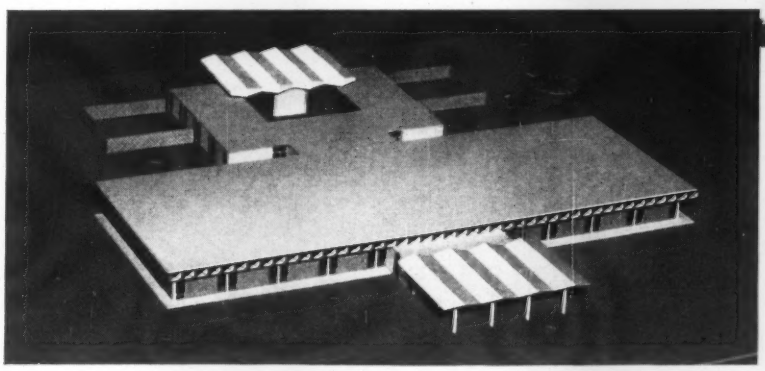
*Acme Packaged Chillers & Air Cooled Condensers*



**Acme INDUSTRIES, INC.**

JACKSON, MICHIGAN • GREENVILLE, ALABAMA

*MANUFACTURERS OF QUALITY AIR CONDITIONING AND REFRIGERATION EQUIPMENT SINCE 1919*

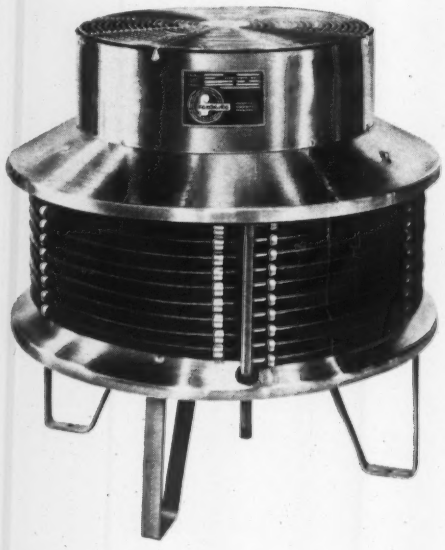


*ARCHITECTS:*
*Frank Grad and Sons, Newark*

*CONSULTING ENGINEERS:*
*Sears and Kopf, New York City*

*MECHANICAL CONTRACTORS:*
*John H. Moore and Son, Atlantic City*

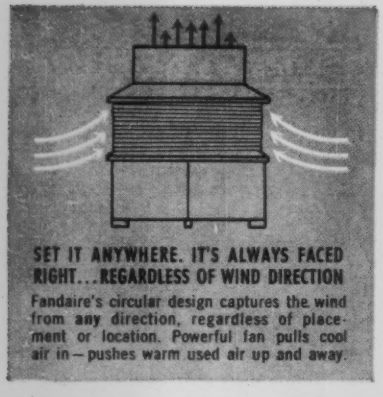
# where a graceful silhouette makes a big difference



## Circular Air-Cooled Condenser design blends with modern building needs

The new Fandaire offers more than architectural compatibility. It combines modern low silhouette lines with an exclusive high-heat dissipating fintube design. Unique in its efficiency, the entire circular spiral of fintubing is flooded with swiftly moving air from every direction, utilizing fully each degree of temperature drop.

Because the Fandaire weighs ⅓ less than conventional installations, it can be positioned where needed, without guy wires or extra bracing. *Savings in piping and installation alone can be considerable.* Fandaire is engineered in sizes from 3 to 120 tons – a model for practically all single or multiple installations. In terms of performance, these are the most economical air-cooled condensers available today. Easy to look at, too. Ask for complete information.


SET IT ANYWHERE. IT'S ALWAYS FACED RIGHT...REGARDLESS OF WIND DIRECTION
Fandaire's circular design captures the wind from any direction, regardless of placement or location. Powerful fan pulls cool air in – pushes warm used air up and away.

*specialists in circular air-cooled condensers*

**YUBA-AIMCO DIVISION**
*801 West 21st Street, Tulsa, Oklahoma*

**YUBA CONSOLIDATED INDUSTRIES, INC.**

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# DUAL-DUCT
through the
# FOUR SEASONS

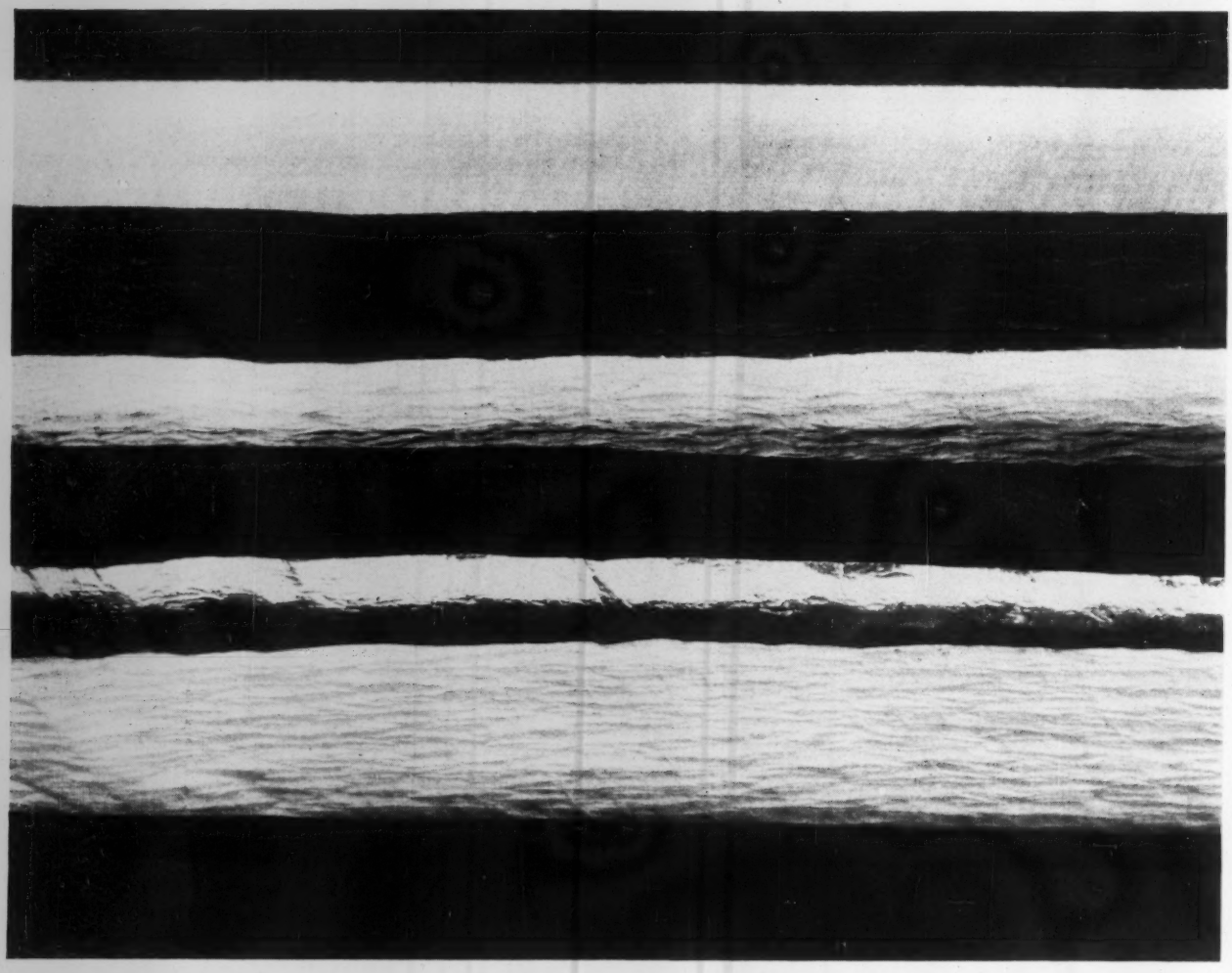
Let North winds blow, Summer sun glow —Buensod Dual-Duct affords complete conditioning through all the seasons of the year, heating and cooling, always maintaining proper conditions in every space. And this Buensod-pioneered "all-air" system, with patented automatic volume-controlled mixing units, provides constant air volume in every zone, regardless of variance in static pressures. That means the installation cannot be thrown out of balance, ever. Learn why Dual-Duct is the logical choice for new and renovated structures alike. Write for Bulletin DD-6 or contact your local Buensod representative and get complete details.

**BUENSOD DUAL-DUCT**

BUENSOD-STACEY

Buensod-Stacey Corp. 45 West 18 Street, New York 11, N. Y.

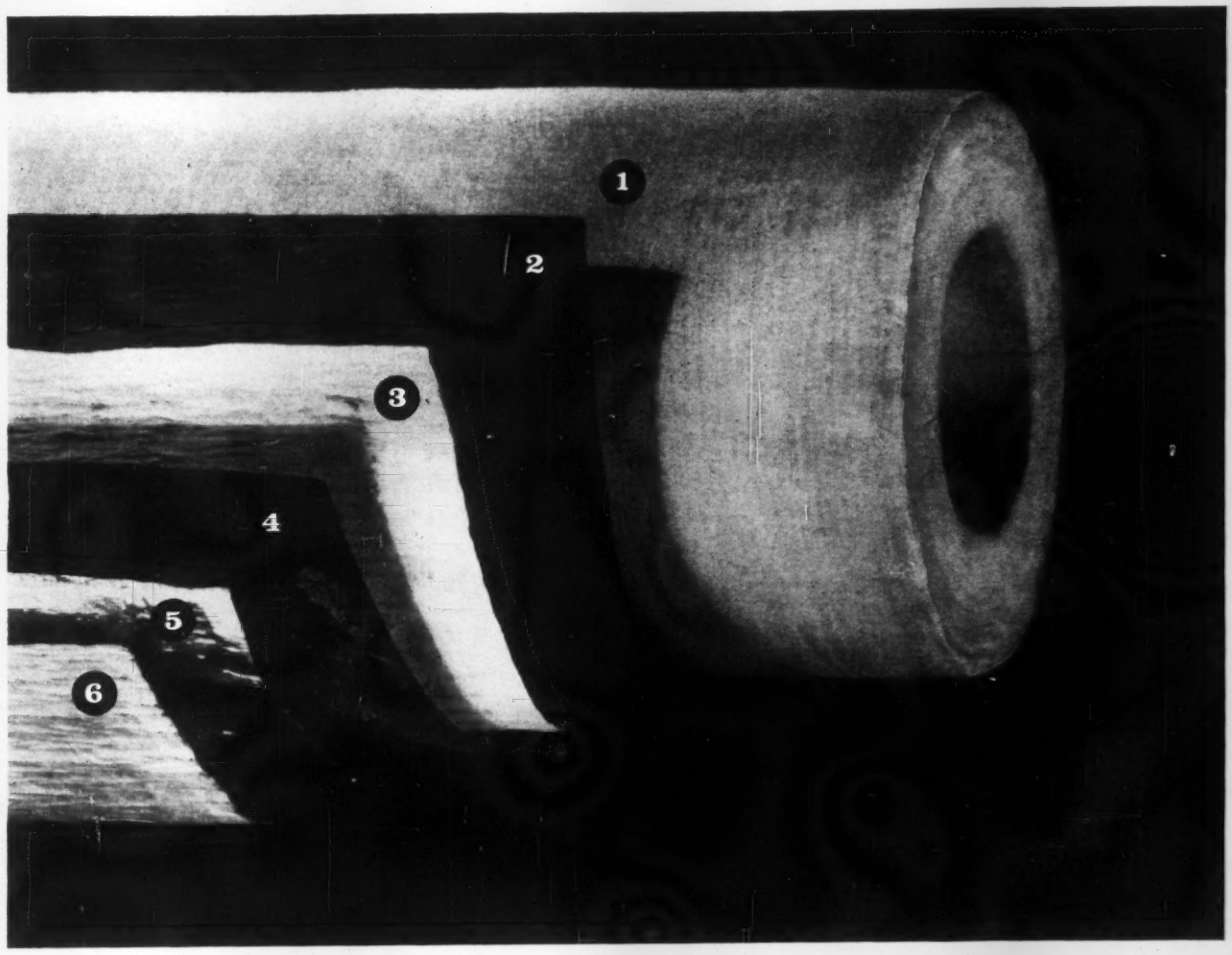
Subsidiary of Aeronca Manufacturing Corporation

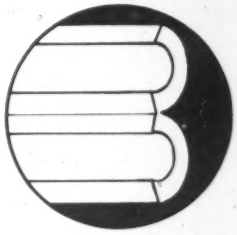


# Name the service condition... J-M Micro-Lok has the jacket

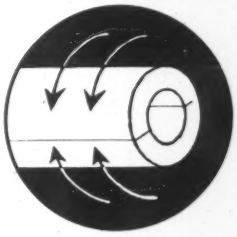
**JOHNS-MANVILLE MICRO-LOK FIBER GLASS PIPE INSULATION OFFERS A COMPLETE LINE OF JACKETS FOR HEATING, COOLING AND PLUMBING APPLICATIONS**

Prejacketing, plus J-M Micro-Lok's exclusive "spring-hinge" action, makes proper application so easy . . . so fast . . . so saving on job-hours. A remarkably low *k* factor assures lower fuel and power costs . . . hot or cold line protection from minus 120 F. to plus 370 F. Other Micro-Lok advantages: feather-light yet rugged resiliency; easily cut to fit joints, hangers or other irregularities. Sizes for all iron pipe and copper tubing and in all standard wall thicknesses.



OPENS EASILY FULL LENGTH



CLOSES AUTOMATICALLY

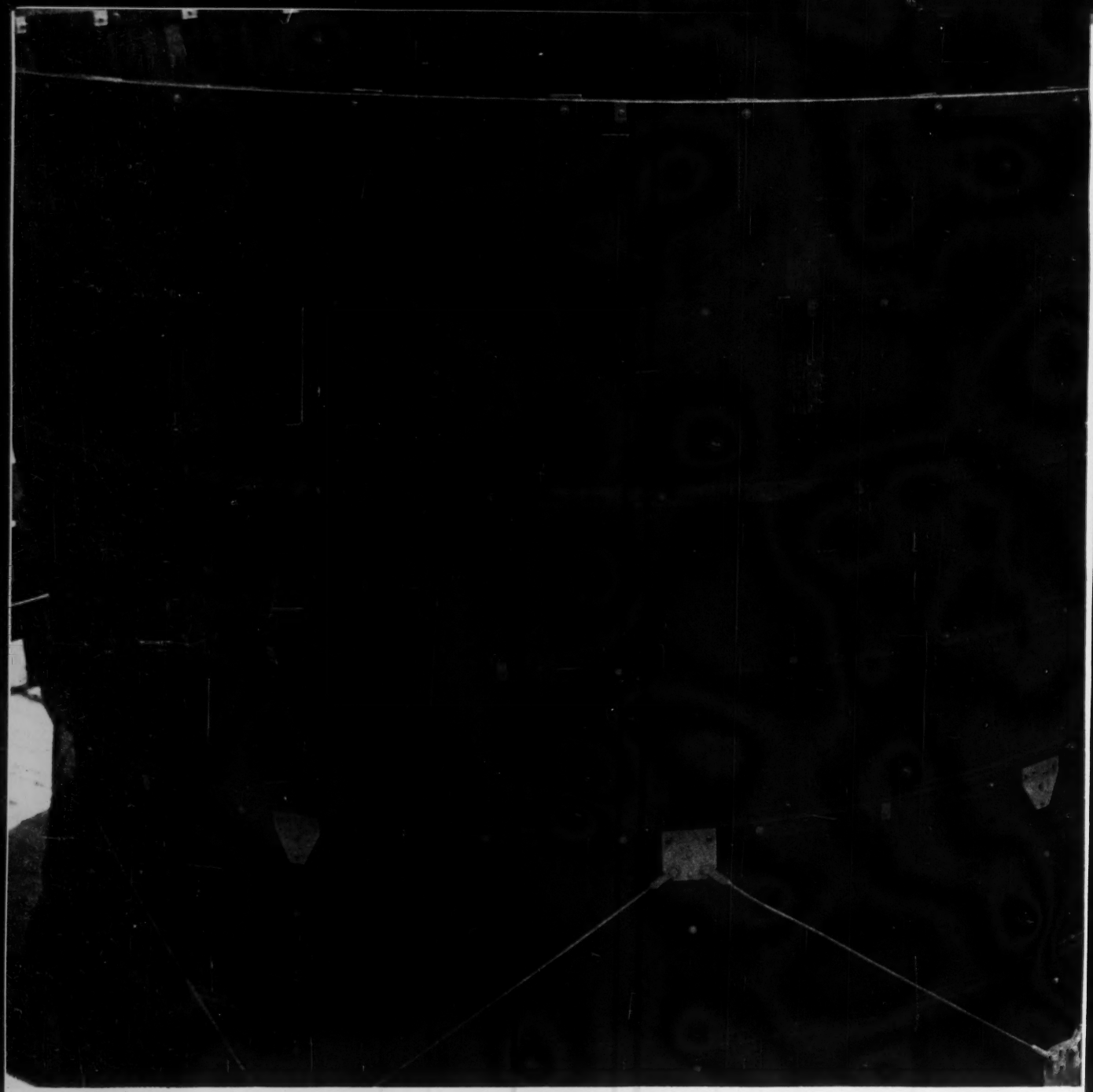
**FACTORY-APPLIED JACKETS**
**TO MEET HOT OR COLD OPERATING CONDITIONS**

| | NAME | DESCRIPTION | APPLICATION |
|---|---|---|---|
| 1 | CANVAS | 4-oz., 6-oz., in addition to standard canvas. All weights available on all insulation thicknesses and sizes. | For exposed hot water supply lines; heating supply and return lines either steam or hot water. |
| 2 | DUAL TEMPERATURE (Black) | Three-ply with 55-lb. black asphalt-impregnated kraft; 0.001" aluminum foil; and 55-lb. black asphalt impregnated kraft. Vapor transmission rate less than .02 perms. | Used for piping below 50 F. (to minus 120 F.) and where piping temperatures vary from cold to hot. |
| 3 | DUAL TEMPERATURE (White) | Three-ply with 60-lb. white bleached kraft; 0.001" aluminum foil; and 55-lb. black asphalt-impregnated kraft. Vapor transmission rate less than .02 perms. | Used for piping below 50 F. (to minus 120 F.) and where piping temperatures vary from hot to cold. |
| 4 | WEATHER RESISTANT | Three weights of asphalt-saturated felt available —35-lb., 45-lb., 55-lb. | For pipe insulation 1" thick and over; for all pipe sizes. |
| 5 | FLAME RESISTANT | 40-lb. flame retardant kraft paper laminated to 0.001" thick aluminum foil by a flame-retardant adhesive. Vapor transmission rate less than .02 perms. Aluminum surface is exposed. | Where codes or other requirements call for a fire resistant jacket. |
| 6 | GENERAL PURPOSE | 60-lb. white bleached kraft laminated to 0.00035" thick aluminum foil. Vapor transmission rate less than .05 perms. Available for ½" and ¾" thicknesses only in all pipe sizes. | Used for cold water and hot water service lines. Can be used instead of canvas on hot water and steam lines. (Not recommended for piping operating below 50 F.) |

For full details call your J-M representative. Or, write Johns-Manville, Box 14, N.Y.16, N.Y. In Canada: Port Credit, Ont.

JOHNS-MANVILLE
FIBER GLASS

JOHNS-MANVILLE JM PRODUCTS



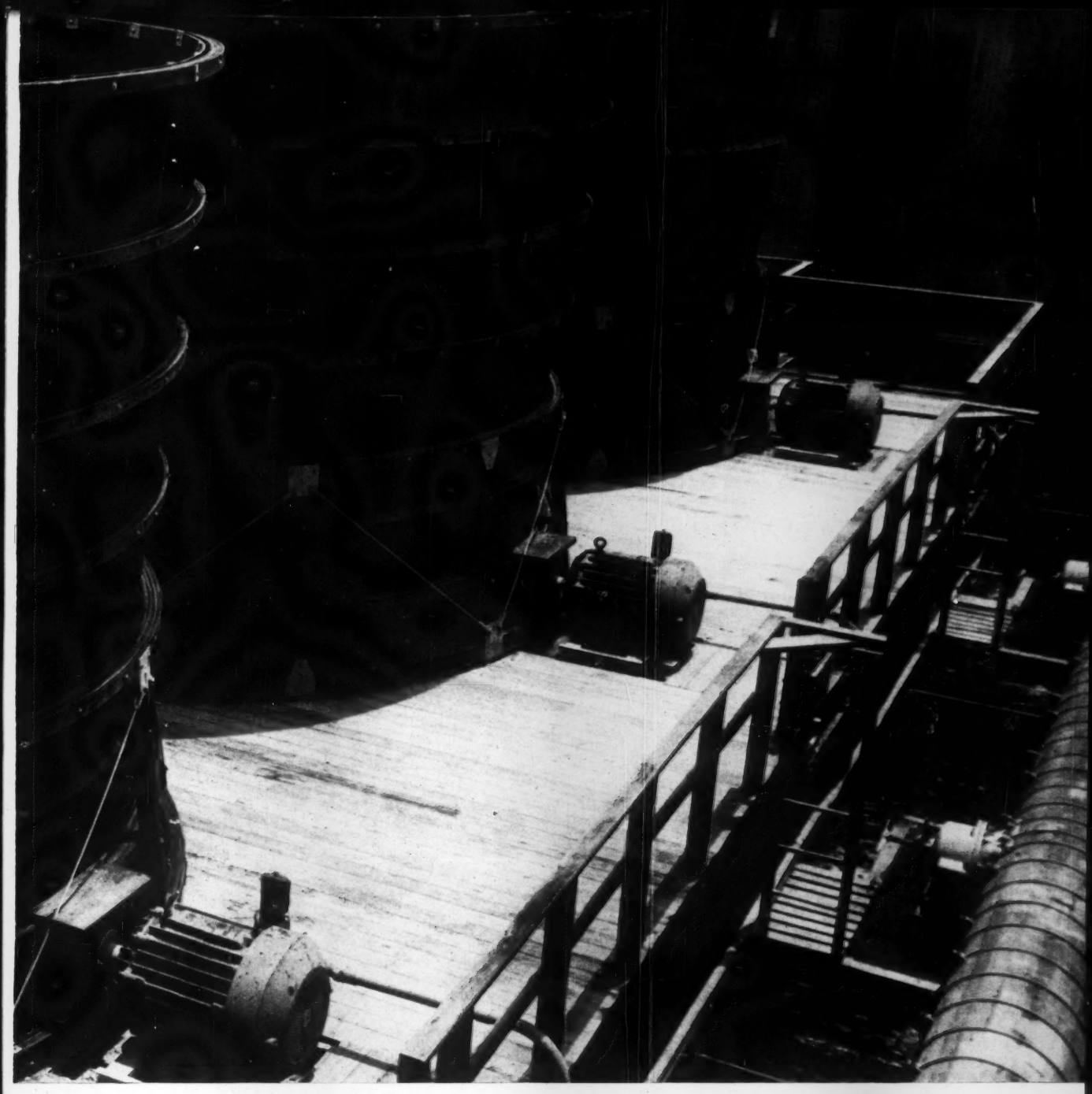
# CENTURY MOTORS PULL HEAT

Forty-two stories above Dallas, on top of the South's tallest building, three Century 50 horsepower totally-enclosed fan-cooled motors are driving induced draft fans to keep the Southland Center cool.

A Century motor drives a 20-foot fan on each of three cells of this cooling tower. During the hot summer months, especially, the air conditioning of the immense Southland Center is dependent upon the continuous operation of these fans—and, upon the dependable, continuous operation of Century motors.

Heat absorbed by air-conditioning and refrigerating equipment must be removed efficiently. Maintaining efficient condensing temperature in a system of this large capacity, requires 20,000 gpm of cold water. And conservation of this gallonage with uniform performance at all times is necessary—the cooling tower is an important factor in the overall system.

Dependable Century motors are a vital part of installations such as this one where the continuous operation of the fans is so important. The three Century 50 horsepower, two-speed, totally-enclosed fan-cooled motors used in this installation are subject to all sorts of



# OUT OF A 42-STORY BUILDING

unfavorable weather conditions—heat, moisture, rain, wind, corrosion. But they keep working . . . continuously. They keep working because these motors are made of strong, tough cast iron and will withstand the elements in unguarded outdoor locations.

These totally-enclosed fan-cooled motors are constructed so that no outside air (with dust, dirt, moisture, etc. in it) is circulated into the motors. Internal fans circulate *clean* air within the enclosed frames. An external fan blows air over the ribbed frames for maximum transfer of heat to the outside air. These Century motors can take it, because they are designed and built to handle such jobs.

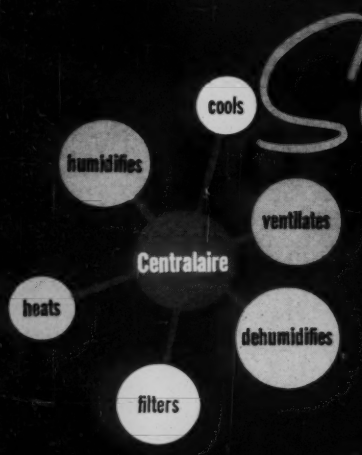
Century application engineers throughout the country understand industry's motor requirements. Call the Century Office nearest you, or your Authorized Century Distributor for more information about Century's complete line of motors—from 1/20 to 400 horsepower.

**CENTURY ELECTRIC COMPANY**

**St. Louis 3, Missouri** *Offices and Stock Points in Principal Cities*

Century

59-24



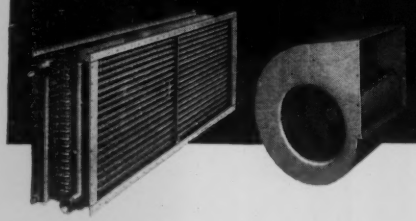

# Sectionalized Design

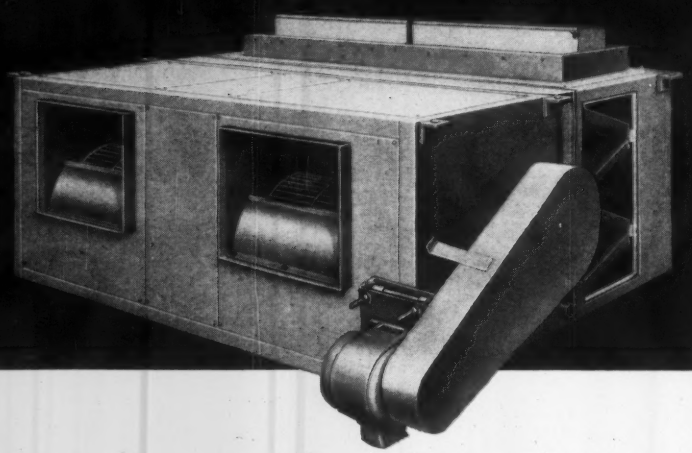
enables one unit to perform up to six different air handling jobs!

## AIRTHERM CENTRALAIRE

### CHOICE OF FAN & COIL SIZES

By using one of two different fan sizes, Centralaires can operate at or near top efficiency regardless of system static pressure and air volume needs. Three coil face area sizes—from which one is selected—enables the coil face velocity to meet design conditions and match the fan.





**GRAPHIC SELECTION METHOD FEATURED IN NEW BULLETIN!**

Contains an amazingly simple graphic selection method for fast, easy sizing. Gives the complete story on Centralaire units. Write for Bulletin No. 404 today!

Versatility that's practically unlimited! Sectionalized design permits *one* unit to meet *both* the space and air handling requirements of any commercial building needing 400 to 30,000 CFM output. Noise has been reduced to a lullaby level.

Utilizing steam or hot water, chilled water or refrigerant, this central station air handling unit performs all the functions of good air conditioning—heating, ventilating, cooling, dehumidifying, humidifying, and filtering, depending on specifications.

Cabinets are handsomely finished in mar-resistant metallic bronze... flush-mounted enclosure panels provide a trim, clean appearance.

See your Airtherm Representative for more information!

**AIRTHERM MANUFACTURING COMPANY**

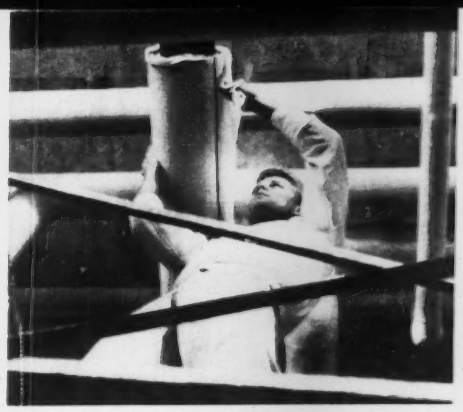
P. O. Box 7039 • St. Louis 77, Mo.

*For steam, hot water, chilled water systems*

CABINET UNIT HEATERS • CABINET AIR CONDITIONING UNITS • VERTICAL & HORIZONTAL UNIT HEATERS • CONVECTORS

**No. 1* in a series for your G-B SPEC. FILE**

# Suggested specifications for insulating INDOOR HEATED PIPING with G-B SNAP*ON Glass Fiber PIPE INSULATION



## DESCRIPTION

G-B Snap*On is the original one-piece, hinged pipe insulation molded entirely of fine glass fibers. It is manufactured in thicknesses from ½" to 3", in 3-ft. and 6-ft. lengths, for cold and heated piping from sub-zero to 350°F. "K" factor of G-B Snap*On is second to none among all general purpose pipe insulations. Because it is made entirely of glass fibers, G-B Snap*On pipe insulation offers all the advantages of glass itself. It will not burn, is not affected by moisture, will not corrode metal, is lightweight and easy to handle and apply, is highly immune to damage, and is so permanent it will last indefinitely!

## SAMPLE MATERIAL SPECIFICATION

**HOT WATER PIPING—Insulating Material**

All hot water service supply piping shall be insulated with Gustin-Bacon Snap*On glass fiber pipe insulation in one piece molded sections ...." thick. Piping shall be clean and dry and shall be tested before insulation is applied.

**LOW PRESSURE STEAM OR HOT WATER SUPPLY AND RETURN PIPING—TO 350° F.—Insulating Material**

All low pressure steam or hot water supply and return piping used for heating, located indoors in unconditioned areas or where touch temperature insulation is required, shall be insulated with Gustin-Bacon Snap*On glass fiber pipe insulation in one piece molded sections ...." thick. Piping shall be clean and dry and shall be tested before insulation is applied.

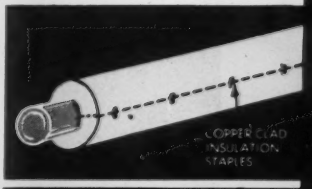
*NOTE: Use facing table below to specify appropriate jacket with above specifications.*

## APPLICATION SPECIFICATION

**INSULATION OF CONCEALED PLUMBING AND HEATED PIPING**

Insulation for concealed piping shall be applied to the pipe without jackets. The end joints shall be tightly butted and the single longitudinal seam held together with copper-clad insulation staples, 4 staples per 3' section.

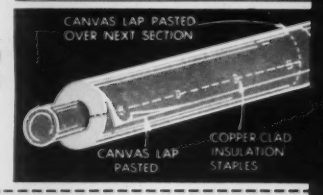
**CONCEALED PIPING**




**INSULATION OF EXPOSED PLUMBING AND HEATED PIPING**

Insulation for exposed piping shall be applied to the pipe with factory applied canvas jackets. The end joints shall be tightly butted and the single longitudinal seam held together with copper-clad insulation staples, 4 staples per 3' section. The factory applied canvas jacket laps shall be neatly pasted in place. *(Note: The insulation may be finished off by applying metal bands, 2 per section. One band shall be placed at the mid-point of the covering and one centered over the joint between sections.)*

**EXPOSED PIPING**




## RECOMMENDED JACKETS FOR G-B SNAP*ON PIPE INSULATION FOR HEATED PIPING

| ORDERING NAME | DESCRIPTION | SEC. LENGTH | VAPOR BARRIER | WHERE TO USE |
|---|---|---|---|---|
| CANVAS | Standard weight or 4, 6, and 8 ounce jackets, factory applied, with end and side joint overlaps. Surface suitable for sizing and painting. | 3' | No | On interior hot piping to 350° requiring no vapor barrier and where finished appearance is an important consideration. |
| LIGHT DUTY JACKET (Available on 1½" and ¾" wall thickness only) | A two layer laminate of .00035" aluminum foil adhered to a 60-lb. white crepe Kraft paper. Presents a neat finished appearance. Moisture vapor transmission rate of less than .03 perms, factory applied with a 2" longitudinal overlap. Joints are sealed with factory furnished 4" wide tapes. | 3' | Yes | On interior hot or cold piping operating at temperatures from 350° F. to 50° F. where a finished appearance is required. For temperatures below 50° F. dual temperature jacket should be used. |
| PLAIN | No jacket. Smooth glass fiber surface. | 3' and 6' Depending on Size | No | On interior concealed hot piping. Excellent for industrial applications where no vapor barrier is required. Perfect when paint or plastic finishes are to be applied in the field, also recommended where weatherproofing jackets, aluminum, or sheet metal coverings are to be field applied. |

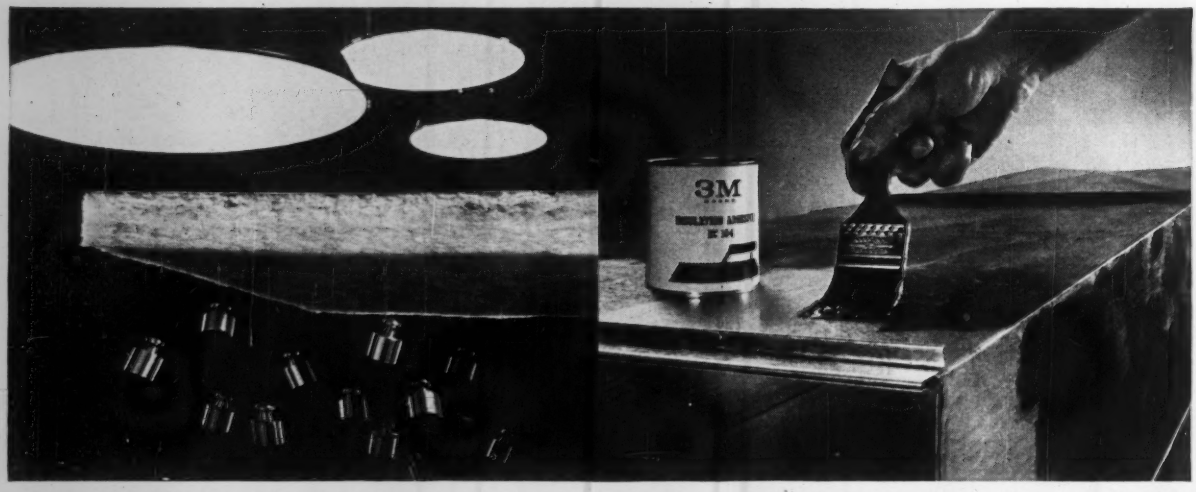
*Complete series of G-B Snap*On specifications will appear in this publication in the coming months. Each will be designed to be clipped from the publication and placed in your spec file. However, if you would like to have all G-B Snap*On specifications at this time, simply write:

GUSTIN-BACON Manufacturing Company
220 W. 10th St., Kansas City, Mo.

GUSTIN gb® BACON

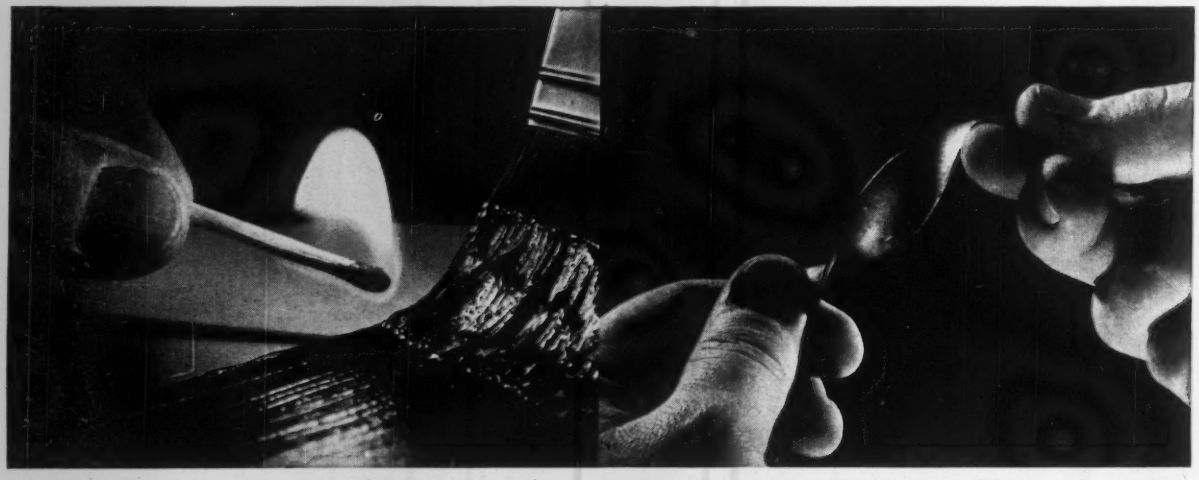
Thermal and acoustical glass fiber insulations . . . Molded glass fiber pipe insulation . . . Couplings and fittings for plain and grooved end pipe

# There's a 3M Brand Adhesive or Sealer for every insulation need!




**High heat resistance!** Adhesive EC-1128 holds tight despite temperatures as high as 300°F; resists moisture so that steam can't loosen the bond. Even keeps its grip at —20°F. And EC-1128 provides both instant grip and long open time to let you do the job right! EC-1128 bonds foil-to-foil lapped seams, too.

**Good coverage!** Adhesive EC-104 provides unusually high coverage . . . quickly and easily . . . for greater economy. One pint covers up to 25 square feet when brushed on. If spray-applied, one pint covers 44 square feet. EC-104 gives you fast grip even when wet. And still . . . you get the convenience of long open time.



**Nonflammability!** Solvent-free Adhesive EC-321 won't burn during application—even near an open flame. You can apply insulation anywhere without fear of fire. EC-321 supplies a durable bond that resists high heat, moisture and vibration. It even bonds through thin oil films. Roll, brush or spray it on!

**High velocity systems!** Flexible Sealer EC-800 can be stretched twice its length before fracturing. It sets up firmly at duct joints, won't flow out of seams under pressure, yet it flexes with duct expansion and contraction. Actually adds structural strength to duct work. Apply with brush, flow gun or putty knife.

**SEE WHAT 3M ADHESIVES CAN DO FOR YOU**—Contact your 3M Field Engineer. Or, for more information and free literature telling how time-tested 3M Brand Insulation Adhesives and Sealers can help solve virtually all your insulation problems, write on your company letterhead to: A., C. & S. Division, 3M, Dept. SBI-120, 900 Bush Avenue, St. Paul 6, Minnesota.

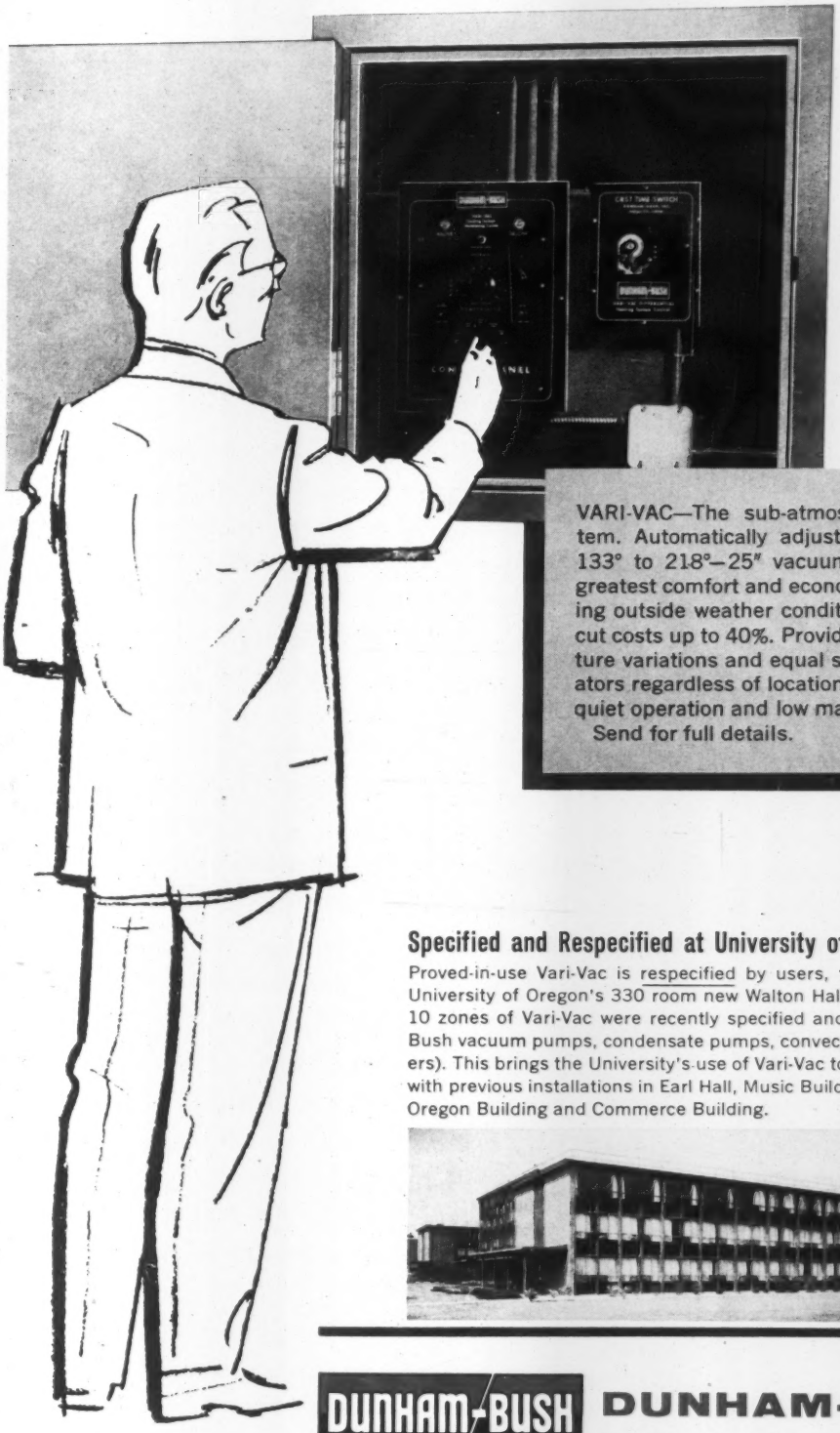
ADHESIVES, COATINGS AND SEALERS DIVISION

**MINNESOTA MINING AND MANUFACTURING COMPANY**

**. . . WHERE RESEARCH IS THE KEY TO TOMORROW**

3M COMPANY

# DUNHAM-BUSH VARI-VAC DIFFERENTIAL HEATING



the system that's specified and respecified

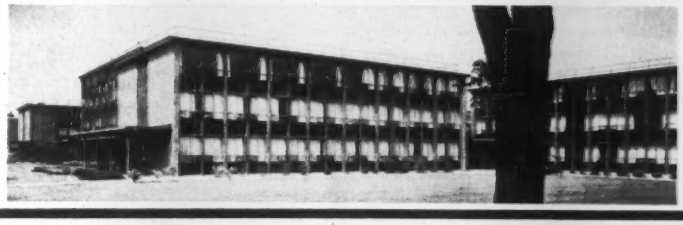
FOR FUEL ECONOMY
FOR GREATER TENANT COMFORT
FOR LOWER SYSTEM MAINTENANCE
FOR PRECISE CENTRAL CONTROL

VARI-VAC—The sub-atmospheric steam control system. Automatically adjusts steam temperature from 133° to 218°—25″ vacuum to 2 lb. pressure—to give greatest comfort and economy of operation with changing outside weather conditions. Effects fuel savings to cut costs up to 40%. Provides minimum room temperature variations and equal steam distribution to all radiators regardless of location and heat demand. Ensures quiet operation and low maintenance.

Send for full details.

## Specified and Respecified at University of Oregon

Proved-in-use Vari-Vac is respecified by users, time and time again. At University of Oregon's 330 room new Walton Hall Dormitory, for example, 10 zones of Vari-Vac were recently specified and installed (with Dunham-Bush vacuum pumps, condensate pumps, convectors, valves, traps, strainers). This brings the University's use of Vari-Vac to over 20 zones of control with previous installations in Earl Hall, Music Building, Journalism Building, Oregon Building and Commerce Building.



DUNHAM-BUSH

**DUNHAM-BUSH, INC.**

WEST HARTFORD 10, CONNECTICUT, U. S. A.

SALES OFFICES LOCATED IN PRINCIPAL CITIES

# Whatever your flexible metal tubing problem, Anaconda's broad design and manufacturing capability can make your job easier

The big corrugated stainless steel tubing assemblies shown above were designed and manufactured by Anaconda Metal Hose for water lines in the missile program. Construction of these 12″ I.D. lines is corrugated stainless steel flexible tubing, reinforced with stainless steel wire braiding; end fittings are floating flanges. This type of tubing can also be produced in other metals as Bronze, Steel, in standard ID's through 16″ and standard lengths of 20 feet.

**Small flexible tubing for small tough jobs, too.** At the other end of the scale are tiny ⅛″ Vibration Eliminators. And in between, the variety of flexible hose assemblies — in size, material, and design — is almost infinite.

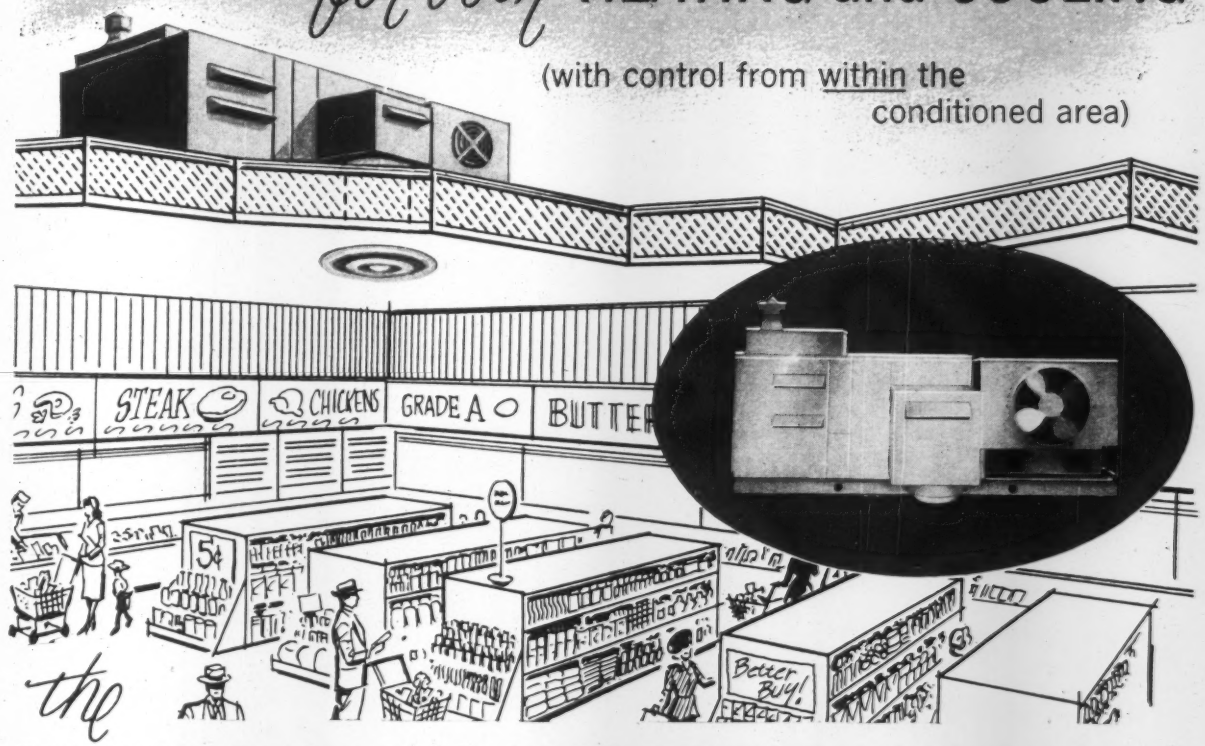
**Sales Engineering Consulting Services** that follow through from original design to finished product. Simply let us know your needs, with conditions, dimensions, and such sketches and drawings as might be necessary to give us an understanding of your problems. We will work out design problems with your engineers and draftsmen. We will manufacture the flexible connectors. And we will make specialists available for immediate service calls on equipment or field installations. These services are available through our representatives in leading cities—see listing "Hose-Metal" in the Yellow Pages. Or write: Anaconda Metal Hose, Box 791, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

**ANACONDA®**
**Metal Hose**

On any single story building...

# *for both* HEATING and COOLING

(with control from within the conditioned area)




## the DUNHAM-BUSH 'RMC' ROOF MOUNTED CONDITIONER

Developed especially to meet the ever-increasing need to conserve space in the conditioned area, Dunham-Bush 'RMC' units are easily installed . . . can be used singly or in combination to meet the needs of any single story building.

Heating or cooling is immediate . . . at the flick of a switch . . . can be modulated as desired. And control (including reset) is entirely from within the conditioned area.

'RMC' units also offer these advantages:

- √ Completely "packaged" design . . . factory wired, with all interior piping assembled.
- √ Air cooled . . . no water service or disposal required means added economy.
- √ Weatherproofed casings for long life, low maintenance.
- √ A.G.A. approved heating unit delivers clean, filtered air . . . damper controlled.
- √ Equipped with electrical starting mechanism and safety controls.
- √ Constructed with weight of all components evenly distributed on rigid channel base.

**For complete information, request form No. 6023.**

**RMC 750**
COOLING 85,000 BTU/HR
HEATING 200,000 BTU/HR
(INPUT)

**RMC 1000**
COOLING 114,000 BTU/HR
HEATING 250,000 BTU/HR
(INPUT)

**Dunham-Bush, Inc.**
WEST HARTFORD 10 • CONNECTICUT • U. S. A.

**DUNHAM-BUSH**
AIR CONDITIONING • REFRIGERATION • HEATING • HEAT TRANSFER
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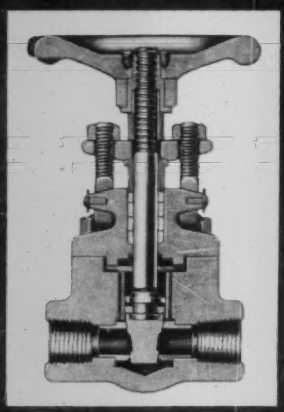
# FORGED STEEL VALVES

*Recommended for:*

- REFINERIES, PETRO-CHEMICAL, POWER, PROCESS INDUSTRIES
- GAUGE, INSTRUMENT, METER LINE SERVICE



## "R-P&C Forged Steel Valves are designed for streamlined safety"

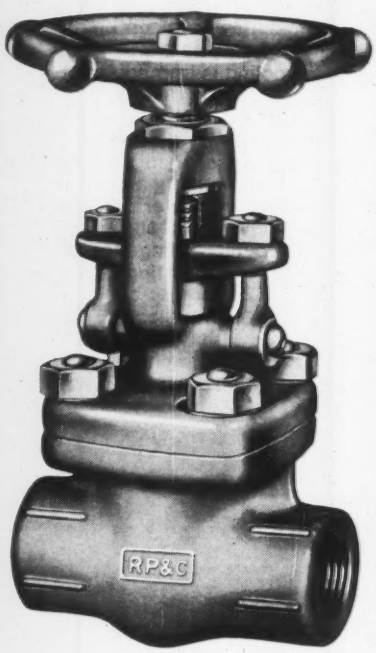
" 'Streamlined safety' is the R-P&C way of saying that this Forged Steel Valve is now lower in weight yet higher in safety than ever before. Thanks to an improved design worked out with leading material specification engineers, all unnecessary bulk and weight in R-P&C Forged Steel Valves have been eliminated. **Ample metal sections** throughout the valve body still give it the highest possible safety factor."

Other new design features like these add up to a long life of trouble-free service:

- **Spiral wound gasket in bolted bonnet joint**
- **Careful heat treatment of parts for strength and wear**
- **Unique stem design to protect stuffing box packing**
- **High quality materials to prevent corrosion**
- **Precision manufacture with exacting standards**

In addition to these Forged Steel Gate and/or Globe Valves, R-P&C distributors offer users in all industries a complete line of R-P&C gate, globe and angle valves in all standard materials: electric furnace iron, bronze, bar stock, cast steel... plus many specialties.

**Contact your R-P&C distributor**




# R-P&C VALVES

ACCO

**R-P&C Valve Division, American Chain & Cable Company, Inc.**

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

# CLOGGING by high wet-strength paper products is IMPOSSIBLE!

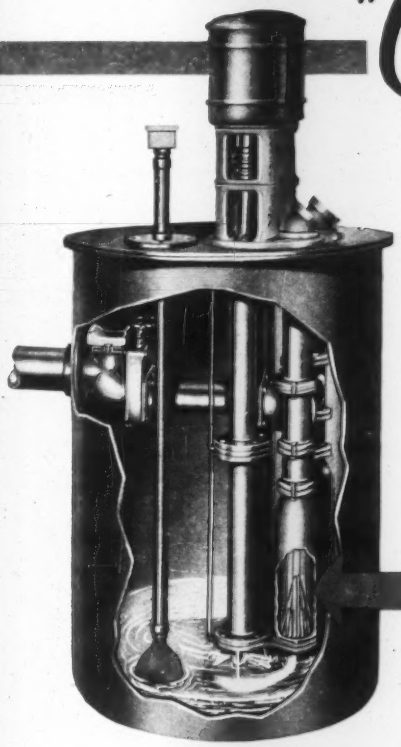
## with the new FLUSH KLEEN® system from "Chicago"

**This clogging cannot happen with the FLUSH KLEEN System**

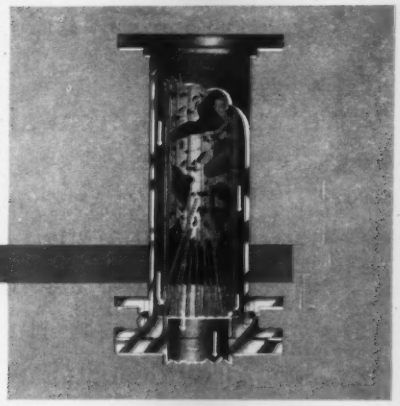
**CLOGGED**— Paper toweling piled up at eye of 2½" sphere design impeller.

**CLOGGED**— Complete clogging of 2½" sphere design impeller.

**CLOGGED**— Complete clogging of 3" sphere non-clog impeller.



**THE FLO-THRU STRAINER,** heart of the Flush Kleen system continuously permits only clear liquid to flow through the strainer into the pump at highest solids loadings.



## SOLIDS NEVER REACH THE IMPELLER

Impeller handles only clear liquid. Shaft, bearings and motor are never subjected to severe strain and wear due to partially or completely clogged impellers. The life of a Flush Kleen system is therefore much longer than that of so-called non-clog type pumps. "Down time" due to clogging is eliminated and a quiet, smooth operating unit is assured.

*For further information see your local Chicago Pump distributor or write Chicago Pump for Bulletin 122-D.*

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*Putting Ideas to Work*

FOOD MACHINERY AND CHEMICAL CORPORATION
HYDRODYNAMICS DIVISION

**CHICAGO PUMP**

622 DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

# We don't know what noise annoys an oyster...

. . . but we do know plenty about eliminating *industrial* noise. Koppers AIRCOUSTAT is the *pioneer product* for controlling duct-transmitted noise in air handling systems . . . and Koppers has the *longest, broadest experience* in the whole field of industrial sound control, from air conditioning to aircraft engines.

AIRCOUSTAT® is the quality standard in its field. Its pioneer engineering is matched by premium construction that features heavier gauge metal than competitive units. It is assembled with care to give the quality performance promised by its original design. And AIRCOUSTAT provides *guaranteed* attenuation certified in the laboratories of independent research organizations.

*Write today* for your copy of the Aircoustat Selection Manual, a quick guide to eliminating noise in all air-handling systems, to: KOPPERS COMPANY, INC., Sound Control Dept., 3312 Scott St., Baltimore 3, Md.

KOPPERS®

**SOUND CONTROL**

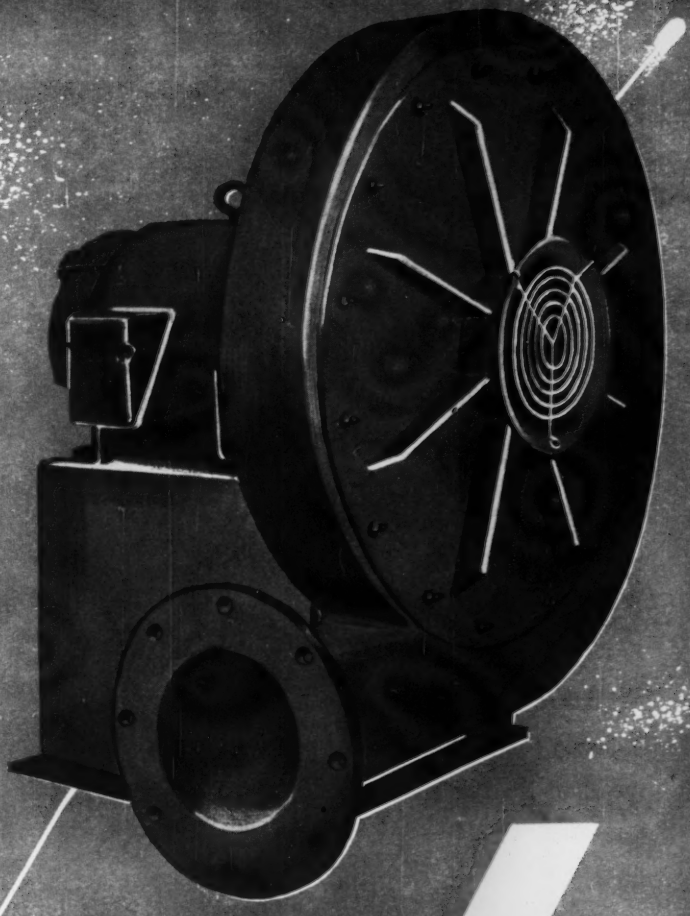
*Engineered* Products Sold with *Service*

Aircraft/Engine Test Enclosures | Portable Jet Run-Up Silencers | Audiometric Rooms | Soundmetal Panels

# PRESSURE BLOWERS

...8 to 32 ounces pressure

...100 to 8200 CFM



nyb

**THE NEW YORK BLOWER COMPANY**

3147 South Shields Avenue • Chicago 16

Write for BULLETIN 603

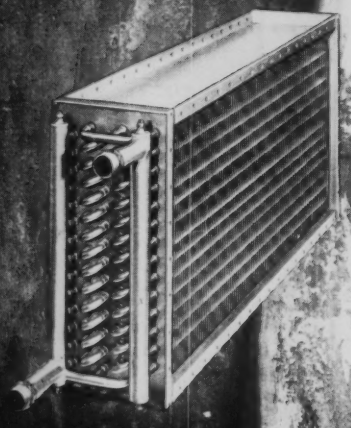
# MARLO COILS SERVE ASSEMBLY ROOM FOR FIRST MANNED SPACE CAPSULE

**Equipment Had Demonstrated Its Quality and Dependability In Previous Installations**

The "Project Mercury" space capsule, designed and built by McDonnell Aircraft Corporation to carry a man in orbit around the earth, is assembled in a "Super Clean White Room" operated under incredibly stringent environmental and hygienic conditions.

The air handling system serving this special chamber at the McDonnell plant is equipped with Marlo heating and cooling coils. Why was Marlo selected for this installation? McDonnell plant engineer George [illegible] says, "We had used Marlo equipment in a previous [illegible] room. Our complete satisfaction with the performance of their units, plus their ability to deliver to meet our tight production schedules answered our coil needs for our space capsule assembly room."

Whether it's an unusual installation like McDonnell's "Super Clean White Room", or an ordinary type of heating or cooling project, you'll find the coils you need in the complete Marlo line. The Marlo representative in your area can give you detailed information.



**MARLO coil co.**

ST. LOUIS 11, MISSOURI

Quality Air Conditioning and Heat Transfer Equipment Since 1914

# New Airfoil Bladed Fans Whisper

Here's a completely new line of Airfoil Bladed Fans from American-Standard Industrial Division with an exclusive radial rim wheel design that substantially lowers air velocity through the blast area of the wheel. This new design, plus airfoil blading, reduces turbulence and results in unusually quiet fan operation. Exceeding 90% in mechanical efficiency, American-Standard* Airfoil Fans are ideal for both general ventilation and industrial process applications. And every one carries the AMCA certified rating seal. Get all the facts. Send for Bulletin A-1103 today. American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario. *AMCA Certified Ratings*

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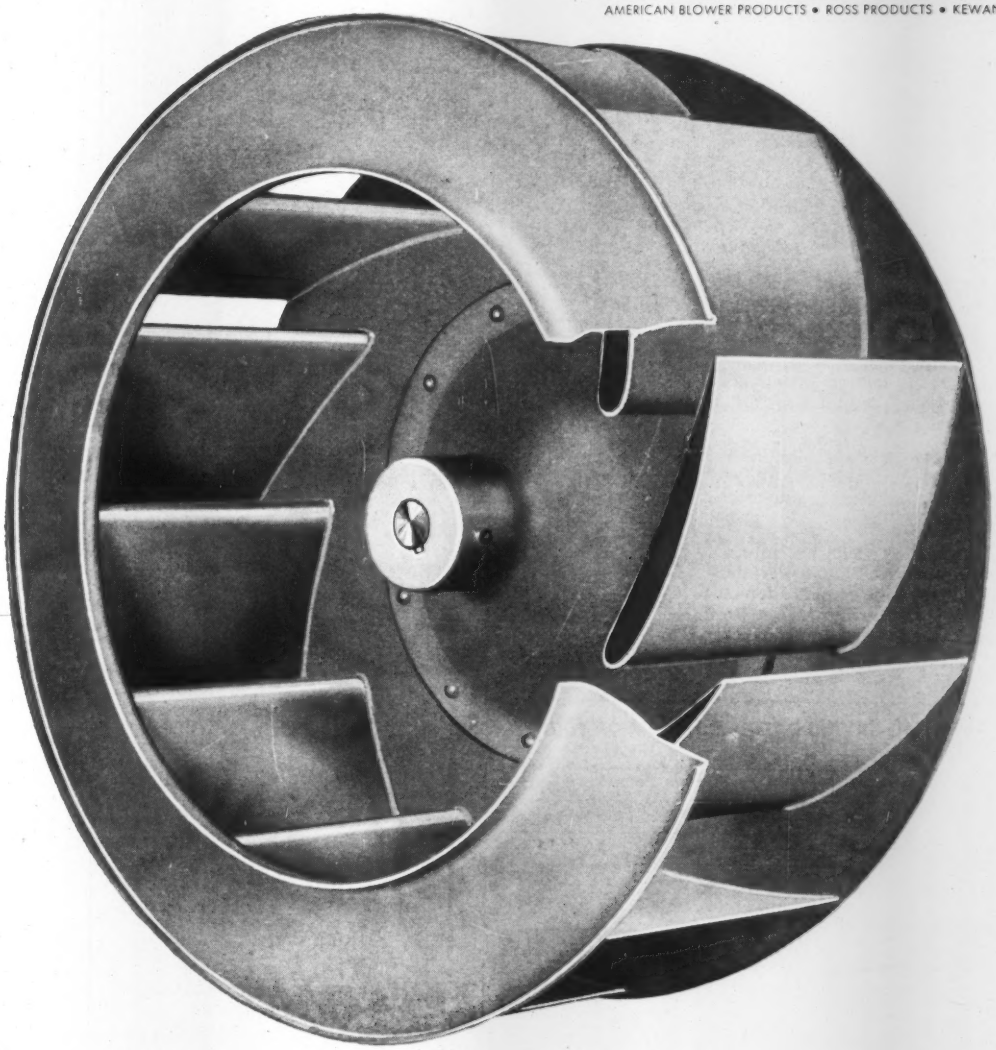


# 80%

★ Fits all ½" to 8" metal or plastic pipe

★ Listed by Underwriters' Laboratories, Inc., Approved by Factory Mutual Laboratory

★ Self-locking, compact, attractive

★ Safe load exceeds rating for standard types—safety factor 5:1

*"AUTO-GRIP" was designed by "Automatic" Sprinkler Corporation industrial engineers for their own use as piping installation contractors. "AUTO-GRIP" ease, simplicity, speed and economy soon established it in the trade as the top improvement in pipe hanging efficiency in 50 years!*

**LOWER INITIAL COST**—competitive with least expensive outmoded, cumbersome rings, bands and clevises.

**SMALLER INVENTORY**—universal adaptability permits quantity buying of fewer types—less storage space.

**SAFER—MORE ATTRACTIVE**—self-locking via spring tension and pipe weight . . . shipped assembled, stays assembled . . . zinc-coated or copper-plated.

**REDUCES LABOR COSTS**—tests by industrial engineers reveal that "AUTO-GRIP" installs in only 20% of the time required for old-fashioned clevis-type rings. Universal, counterbored hanger insert secures quickly to ceiling hanger rod. Insert is adjusted easily on rod by finger strength.

**HOW "AUTO-GRIP" WORKS**

Release insert—ring swings open

Ready to slip over pipe

Squeeze—replace insert

**FREE SAMPLE • TIME-SAVING DATA • MAIL COUPON TODAY!**

NAME_____ POSITION_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

#160A

AUTO GRIP "Auto-Grip" Division
® Box 360 • Youngstown 1, Ohio
"Automatic" Sprinkler CORPORATION OF AMERICA



**Great names—that made scientific filtration possible!**

**Pascal's Law:** $\frac{F}{A} = \frac{F1}{A1}$

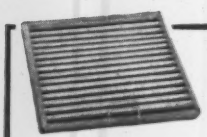
"Pressure exerted anywhere on a confined liquid is transmitted undiminished throughout the interior of the containing vessel."

*Blaise Pascal (1623-1662)*

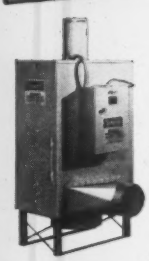
Although Pascal's Law is more than 300 years old, it is still one of the basic principles that must be taken into consideration in the design of new products for modern industry. And Air-Maze engineers, in their specialized field of developing better methods of filtering liquids and gases, are ever conscious of the importance of Pascal's discoveries.

For 35 years, whatever the filtration requirements—hydraulic presses or jet aircraft, air compressors or vacuum pumps—Air-Maze has been at work keeping equipment running better and longer by keeping it clean and free from damaging contaminants.

The products shown below are representative of the many designed and developed by Air-Maze engineers to meet special filtration requirements. If your product involves any gas or liquid that moves, Air-Maze can help you.



Only Air-Maze P-61 Permanent Dry Type panels combine extended area with water-washability. Result: lower resistance, greater dirt holding capacity.



Misti-Maze electronic oil mist and fume eliminator permits air recirculation, reducing heating or cooling load. Ideal for machining or welding operations. Includes motor and exhaust fan.

**OTHER AIR-MAZE PRODUCTS:**
Air Filters • Liquid Filters • Intake Silencers • Exhaust Spark Arresters Breather Filters • Oil Mist Eliminators

AIR-MAZE
CLEVELAND 28, OHIO
A SUBSIDIARY OF ROCKWELL-STANDARD
ROCKWELL R STANDARD

# Armstrong announces Armaflex 22 —a new, improved pipe insulation

An improved flexible foamed plastic pipe covering, with a broader temperature range and a super-smooth surface finish, has been developed by Armstrong.

This easy-to-apply insulation can be used on hot lines operating up to 220° F., as well as on all cold piping at temperatures down to zero and below. The new, smooth surface gives every installation a neatly finished look.

In addition to being an efficient insulator, Armaflex 22 has high resistance to water and vapor penetration, is self-extinguishing, ozone resistant, and has negligible odor.

Armaflex 22 is made in 6-ft. lengths, in ⅜", ½", and ¾" wall thicknesses for pipe and tubing from ⅜" to 3⅛" i.d.

For free booklet on Armaflex 22, write Armstrong Cork Company, 2203 Sherman Street, Lancaster, Pa.

**COMPARISON CHART**

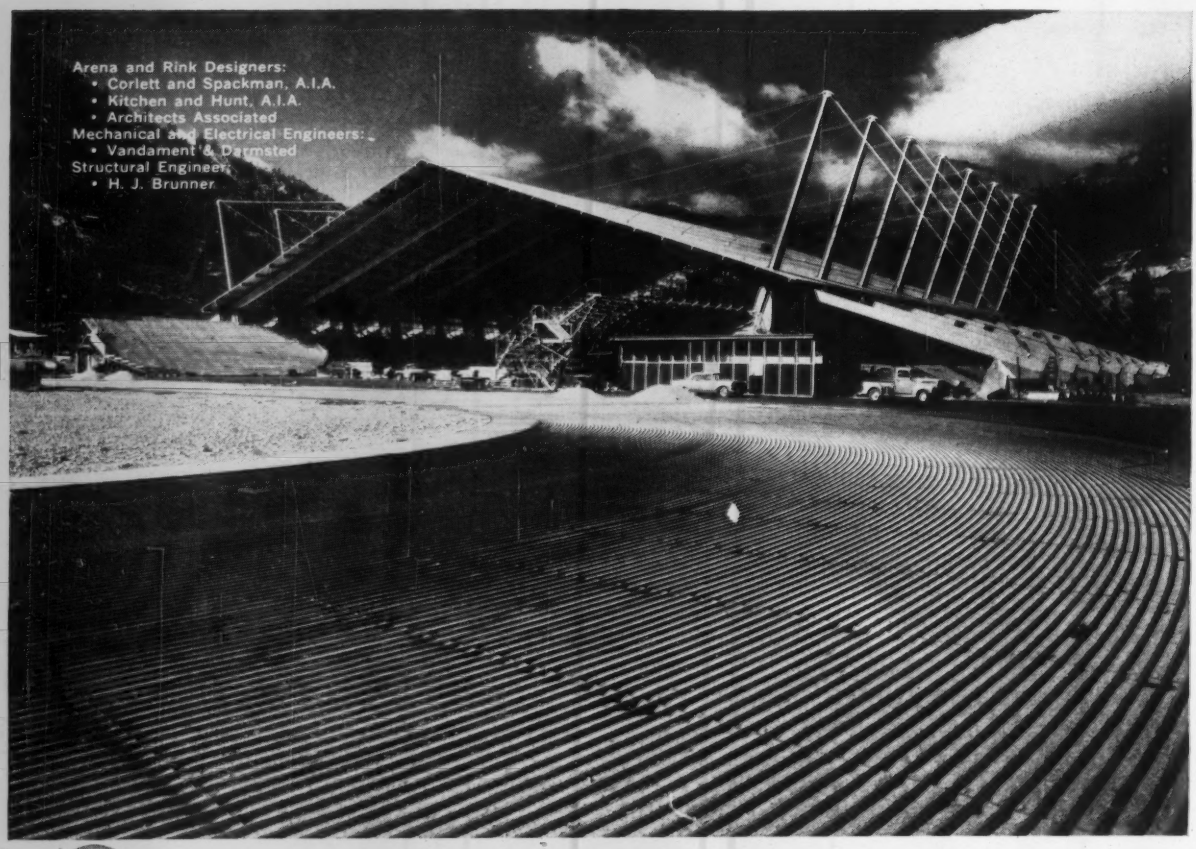
Here's how the physical properties of Armaflex 22 compare with other flexible foamed plastic pipe coverings.

| Physical Properties | Armaflex 22 | Brand A | Brand B | Brand C | Brand D |
|---|---|---|---|---|---|
| Low Density less than 7.5 lb./cu. ft. | Yes | No | Yes | Yes | Yes |
| Low Water Vapor Transmission less than .15 perm | Yes | No | No | Yes | No |
| Low Water Absorption less than 3% by volume — 28 days | Yes | No | No | Yes | Yes |
| Dimensionally Stable at 220° less than 5% lineal shrinkage — 28 days | Yes | No | No | No | No |
| Dimensionally Stable at 200° less than 5% lineal shrinkage — 28 days | Yes | Yes | Yes | No | No |

Properties evaluated at Armstrong Research and Development Center

**Armstrong INSULATIONS**

*1860-1960 Beginning our second century of progress*




# Versatile **steel pipe** helped put and keep the Winter Olympics in championship form

Over 100 miles of steel pipe kept Squaw Valley's ice rinks just "wet" enough. 48 different check points throughout the system protect against danger spots and make-to-order "hard" ice for hockey, "wet" ice for racing.

Interested in steel pipe ice making systems? Write for booklet: "Steel Pipe in Ice Skating — The story behind the new approach to an old sport."

**COMMITTEE OF STEEL PIPE PRODUCERS**
150 East Forty-Second Street, New York 17, New York

*Steel pipe* was busy behind the scenes as America took a rink-side seat at the 1960 Winter Olympic ice show. Inches beneath the flashing skates, over 100 miles of *steel pipe* were making and keeping the world's largest expanse of man-made ice in top form.

While *steel pipe* was freezing 120,000 square feet of ice on the ground, it was busy melting snow on the roof.

Award winning Blyth Arena designed to give 8500 spectators an unobstructed view of the ice show is covered by 300 feet of roof suspended from steel cables. *Steel pipe* coils provide heated air for snow melting on the arena's roof to defend against the crushing load of Squaw Valley's 450 inches of annual snow fall.

The reasons that make *steel pipe* first choice for ice making and snow melting systems at Squaw Valley are good ones.

1. *Steel pipe* handles heat and cold without serious contraction and expansion problems.
2. *Steel pipe* does not present major installation problems. It is formable; has unsurpassed load bearing ability.
3. *Steel pipe* is economical.
4. *Steel pipe* in quantity is available quickly everywhere.

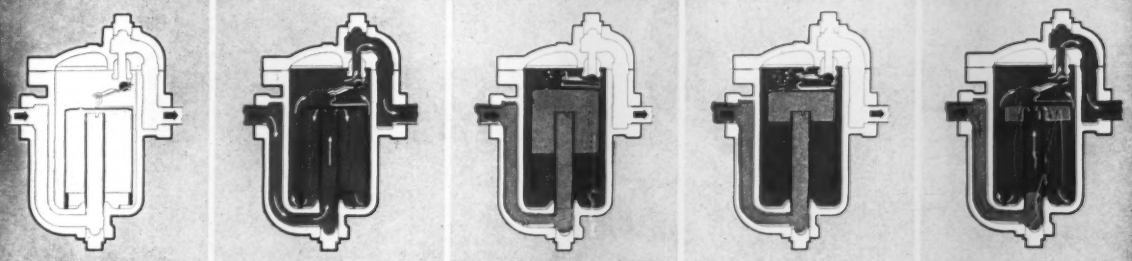
STEEL PIPE IS FIRST CHOICE

- Low cost with durability
- Strength unexcelled for safety
- Formable—bends readily
- Weldable—easily, strongly
- Threads smoothly, cleanly
- Sound joints, welded or coupled
- Grades, finishes for all purposes
- Available everywhere from stock

Insist on MADE IN USA Steel Pipe

C-8

## This simple trap operating principle provides the efficiency, dependability and freedom from maintenance necessary for the most profitable use of steam



When trap is first installed, the inverted bucket is down and the valve is wide open.

When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until —

Steam (light color) reaching the trap floats the inverted bucket and closes the valve.

When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.

When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

Key: condensate steam steam bubbles air bubbles

# ARMSTRONG INVERTED BUCKET STEAM TRAPS

## are designed and made to give you these big benefits:

● Amstrong Traps, the first inverted bucket steam traps, now represent the most advanced development of this time-proven principle. They provide all the advantages necessary for efficient, economical condensate drainage from virtually all types of steam using equipment.

1. *No steam loss* – Steam never reaches the orifice even when there is no condensate load.
2. *Automatic air elimination* – Vent in trap bucket passes air and other non-condensibles through to be discharged with condensate.
3. *No cooling leg required* – Condensate is discharged at steam temperature as fast as it reaches the trap because trap operates on difference in density between steam and water not on temperature.
4. *Operates on any back pressure* – Failure of one trap in system will not cause others to open because high back pressure does not affect an Armstrong trap other than to reduce capacity. As long as there is a pressure differential across the orifice the trap will close on steam and open for condensate.
5. *Unaffected by ordinary dirt* – Swirling action of condensate keeps dirt in suspension until discharged with condensate, prevents it from lodging in valve.
6. *Completely dependable* – Proved design plus the use of all stainless steel working parts assure continuity of service and length of service unmatched by any other trap.
7. *Big capacity in a small, economical package* – Armstrong design gives you the highest practical capacity for any given pressure. And remember, Armstrong capacity ratings are based on *hot* condensate at the *working pressure differential* stated, not on theoretical orifice capacities.

Further information on these advantages plus much additional information is given in the 48 page Armstrong Steam Trap Book. Ask your local Armstrong Representative or write direct.

860 Series for low pressure heating service.

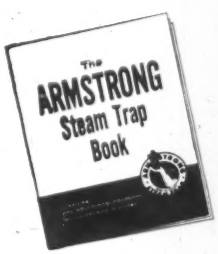
800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.




The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

**ARMSTRONG MACHINE WORKS**

**8749 Maple Street • Three Rivers, Michigan**

"See Our Catalog in Sweet's Industrial Construction File.

# 53 FRICK REFRIGERATING AND AIR CONDITIONING UNITS SERVE ST. LOUIS MEDICAL CENTER

***Frick Equipment Used Exclusively For Original Equipment Plus 37 Additional Orders In Past 16 Years.***

The Barnes Hospital-Washington University Medical Center in St. Louis is a good example of the dependability and versatility of Frick refrigeration and air conditioning equipment. Since 1944, when the first unit of Frick equipment was installed, 37 repeat orders have raised the number of Frick units to 53.

Today, 13 "ECLIPSE" compressors, 29 low pressure units, and 11 unit air conditioners are in service.

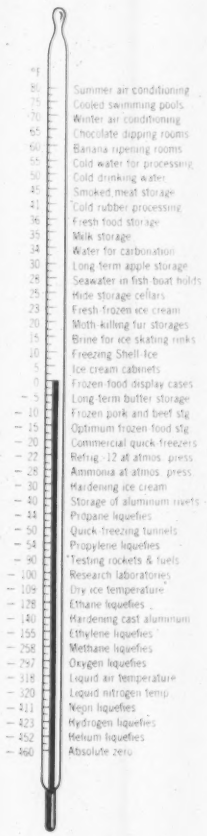
The medical center facilities themselves have expanded to include eight hospitals with nearly a thousand beds, schools of nursing, dentistry, and occupational therapy . . . clinics, laboratories, lecture rooms, and libraries.

All of the air conditioned operating rooms are provided with 100% fresh air which is filtered electrically. The main kitchens, cafeteria and dining rooms are all air conditioned with Frick equipment. All cooler and freezer units are automatically defrosted. Some units maintain temperatures from 0° to 100° F., with varying humidity control.

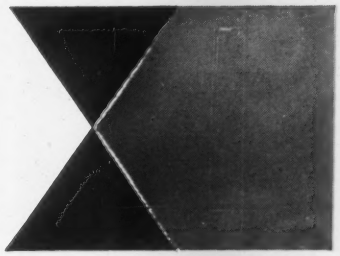
In some special research projects, dual refrigeration equipment with indicating red lights has been installed.

If your interest is industrial or institutional refrigeration or air conditioning, a Frick engineer will be happy to discuss it with you at no obligation.

**FRICK COMPANY**
**Waynesboro, Pennsylvania**



We follow here each month the practice at engineering society meetings of providing an "open for discussion" period. You are urged to take part. Just address your comments to the Editors, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.



# "Open for Discussion"

## Questions Exhaust of Six Million Btu Per Hr In Heat Treating Plant

THE ARTICLE *New Ventilation Design Cools Plating, Heat Treating Plant* (Sept.) is very interesting. It shows that management is interested in improving in-plant conditions and that qualified engineers, by using existing information and drawing on their own personal experience in the field, can design equipment that will produce the desired environment.

Although it could be easily overlooked, it is noteworthy that wherever possible radiant energy sources from the heat treating operations were shielded to reflect the radiant heat back to the furnace rather than allowing it to be dissipated into the room.

Considering the efforts that were made to control all of the contaminants generated and the cold weather for which Minnesota is noted, I wonder if any consideration was given to salvaging some of the 6,000,000 Btu's which are released in the heat treating room. It would seem possible that some of this air would not be sufficiently contaminated but what it could be diluted and used as air supply, or that heat exchangers would be practical to use in tempering either hot water or incoming air.

The cooling system used in summer to provide a good environment in the heat treating area is certainly worthy of note. Few plants are so fortunately located that they would have sufficient cold water available to cool the air to the degree to which they are able. With 95 F dry bulb and 75 F wet bulb design temperatures, evaporative coolers should work satisfactorily in such an installation in providing suitable environment for the employees with considerable less usage of water. It would, however, require greater quantities of air at higher velocities.

As was stated in the article, at first glance the quantities of air used to control the contaminants from the plating operation would seem to be rather excessive. The article states that an attempt was made to reduce the volume but that original design conditions were considered to be the minimum that were satisfactory. In many installations where a number of tanks are placed adjacent to each other, it has been found that these volumes can be reduced by as much as 40 percent and still maintain satisfactory control. The reason for this is that these standards have been selected for individual tanks. When large quantities of tanks are placed adjacent to each other, the overall volume of air is so great that any minor quantities of contaminant that escape are returned to the hoods by the volume of air being handled. The statement that an air change every two minutes is generated by this exhaust bears this out.

Their approach to the problem of eliminating residue fallout is not new but apparently it has worked more satisfactorily for them than with many other companies. Having had experience with a number of cases where similar attempts were made to eliminate the necessity of a suitable collector on the exhaust from the chromium plating tanks, it seems to me a dangerous procedure. One installation was carried on successfully for about five yrs and then complaints were voiced on spotting of automobiles in nearby parking lots. Careful investigation showed that small particles had accumulated in the ducts, dried out, became airborne and were discharged to fall on flat surfaces during a time when there was enough moisture in the air to react with it and cause spots.

It is difficult to understand why air is furnished to heat treating areas at 70 F and yet no effort at all was made to reduce the temperature in the plating room. As was stated, the plating area has a high latent load whereas it would all be sensible heat in the heat treating area. It would, therefore, seem more logical to use evaporative coolers for the heat treating area and to use the coils as described for the control of the air temperature to the plating area.

(*Continued on page 94*)

## "Open for Discussion"

Continued from page 93

In spite of my questions on some phases of the installation, it would seem that the engineers should be complimented on their approach to the problem as well as management for their overall interest in making such areas more pleasant and comfortable.

K. E. Robinson
*Ventilation Engineer*
*Industrial Hygiene Dept.*
*General Motors Corp.*

The Author's Reply — Mr. Robinson's work in the ventilation field is well known. Many factors leading to decisions on how to solve the ventilation problems at the plant under discussion were not brought out in the original article. The points Mr. Robinson raises indicate further discussion is of interest.

We also were much disturbed with the prospect of throwing heat away at the rate of 6,000,000 BTU per hr. Our attempts to recover this heat proved recovery to be uneconomical for the following reasons:

1) Temperature difference between room air and existing air averages 50 F. This small temperature difference would require excessively large heat exchange equipment to make the recovery of heat from furnace exhaust air efficient. The low temperature of furnace cooling water would make recovery of this heat loss inefficient also. The balance of this 6,000,000 Btu per hr is exhausted from the ceiling of the building by power roof ventilators. A considerable proportion of this potential loss is recovered by drawing return air for the ventilation system from a grille next to the ceiling.

2) Since it is necessary to provide heat for the building when the furnaces are shut off, it would still be necessary to provide steam coils for this supplemental heating. Actually, very little steam is used during even the coldest weather when all the furnaces are running, since outside air is tempered with hot room air taken from the ceiling of the heat treating area. Because steam coils will be required, the reduced operating cost resulting from use of recovery equipment does not provide economical justification of the added investment for recovery equipment.

3) The Minnesota Health Code will not permit recirculation of the exhaust air to the room even if the air is filtered.

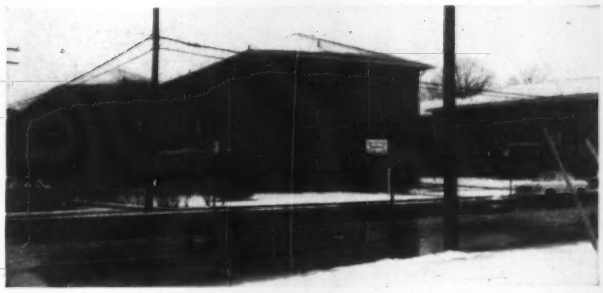
An evaporative cooling system was first considered for cooling the heat treating area. This system was abandoned in favor of refrigerated cooling in that it is necessary to use 250 gpm of process water anyway. The process water being used has a total hardness of approximately 300 ppm. This hardness, by experience causes extreme calcium cake problems when used in evaporative applications. Thus, the first cost and operating cost of the heat treat cooling system is reduced by using well water for cooling.

In regard to plating tank ventilation, it should be noted that the total number of tanks in the plating room is three to four times the number of ventilated tanks and most often these ventilated tanks are not adjacent to each other. It was impossible to finally determine, without actually operating the ventilating system, whether or not air volumes could be reduced. As was stated in my article, we did experimentally attempt to reduce the exhaust rates under actual operating conditions and found the desired air volumes to be approximately a minimum for satisfactory operation. The observation that led to this conclusion was that quite large amounts of water vapor could be seen escaping from the hood area when the reduced air volumes were being used. A further observation worthy of note here is that operation of the two speed exhaust blowers at the reduced speed results in noticeable odor and a general haze within about an hour after reducing blower speeds.

Mr. Robinson's observation of the problems resulting from elimination of fume washing equipment was also noted during our observation of existing installations. The IBM plant maintenance force has set up a schedule calling for the complete cleaning and inspection of the entire plating ventilation system annually. This annual program has resulted in two cleaning operations to date. The accumulated residue will only be a fine film after one year of operation. In fact it is quite difficult to remove this film from the internal surfaces of the exhaust ducts. However, I believe Mr. Robinson would be very correct in his prediction if ducts were left uncleaned for five years.

Mr. Robinson also commented on the possibility of cooling the plating area. The design decision was made that it would be better to do a good job of cooling the heat treating area and bring its maximum ambient temperature to 92 F, rather than to do a partial cooling job in the heat treating and plating areas. A quick analysis will show that 250 gpm of 52 F water will have very little effect on cooling 250,000 cfm of 95 F DB, 78 F WB air. Although evaporative cooling could have been used in the heat treating area, it would still have been impossible to satisfactorily cool this large quantity of air to the plating area; therefore, all the water is used to refrigerate air to the heat treating area. It will also be noted that the maximum temperature of both areas are about the same. Our only desire was to reduce the excessive temperature usually associated with heat treating operations rather than to provide a high degree of personal comfort in these areas.

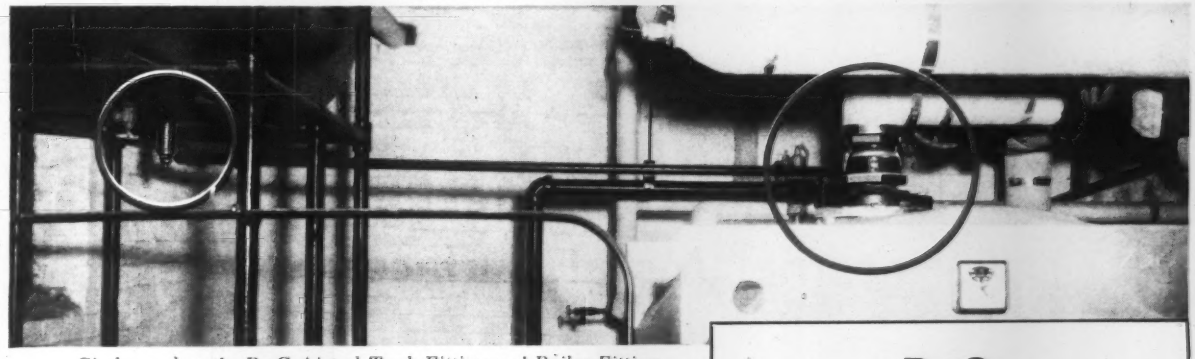
Neil H. Hanson,
*General Manager*
*Comfortrol Supply Co.*



*Shirley Park Apartments, Arlington, Va.*

# "AS IF BY MAGIC, AIR TROUBLES VANISHED"

**writes user of B&G Airtrol System**



*Circles enclose the B&G Airtrol Tank Fitting and Boiler Fitting.*

*Mr. Daniel C. Long*

"Mr. Edwin B. Tidd,
Mgr. of Field Research,
Bell & Gossett Company

"Dear Mr. Tidd:

"We have been plagued by air in the top floor radiators throughout the projects we manage. Bleeding relieved the condition temporarily, automatic vents helped in some cases; however, complaints continued to pour in and our engineers worked around the clock without being able to correct the condition.

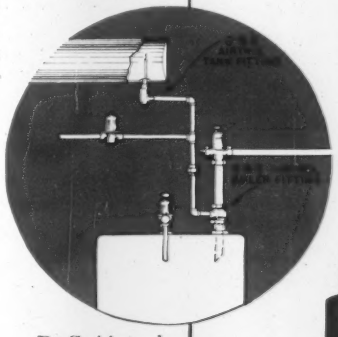
"By chance, we read an advertisement of your 'AIRTROL.' Knowing that any Bell & Gossett product can be purchased without the slightest doubt of its representation, we had the Airtrol installed on three new boilers in a section under construction. We have been free of heat complaints in the new section.

"After one year, we installed three Airtrols on the boilers serving buildings in older sections where complaints were heaviest. The results were beyond belief; as if by magic, our troubles vanished.

"This letter is to thank you, your great organization, and Mr. Curt Sundell, your most efficient representative here, for the complaint-free heating season where the Airtrols are installed.

"Thirty-five boilers heating the projects which we manage will be equipped with Airtrols this summer.

Very truly yours,
M. T. BROYHILL & SONS CORP.
(*signed*) Daniel C. Long, C. E.
Property Management Consultant"



B&G Airtrol System installed on top outlet boiler.

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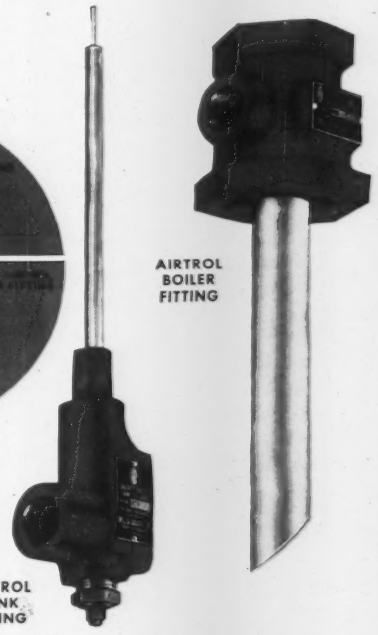


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**COMPANY**
**Dept. GL-5, Morton Grove, Ill.**

*Canadian Licensee: S.A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ont.*

# question of the month

## "How Can We Protect Boilers' Internal Metal Surfaces?"

***This question was asked previously in Heating, Piping & Air Conditioning and is repeated here, along with two answers that have been received from readers. An additional answer was presented in the November issue. Other solutions or comments are invited.***

*"A problem we have been encountering is the deterioration of the internal metal surfaces of our steam and hot water boilers, as well as some heat exchangers. This condition seems to get worse with higher temperatures.*

*Are there any compounds or surface coatings available which retard or prevent this deterioration? If so, how are they applied? What are their compositions? What temperature and pressure limitations should be considered in their application?*

*Any information others can offer will be greatly appreciated."—P.D.W.*

### Low Alkalinity, Oxygen Content Gives Effective Corrosion Control

CORROSION of boiler water sides is a special case of electrolytic action. Iron in contact with water tends to go into solution and under the influence of an electric current the rate of solution is more rapid in the anodic (positive) areas. The inevitable chemical and physical variations in the surface of the boiler metal have corresponding slight electrical differences so that the surface of the metal in contact with the water consists of a multitude of tiny electrolytic cells, each with its anode and cathode. Iron tends to go into solution at the anodes and atomic hydrogen "plates out" at the cathodes in accordance with the following reactions:

1) $Fe$ (tube metal) $-$ 2 electrons $= Fe^{++}$ (ferrous ion)
2) $2H^{+}$ (hydrogen ion) $+$ 2 electrons $= 2H$ (atomic hydrogen)

This effect cannot be prevented, but it can be reduced to a tolerable minimum by maintenance of the conditions which keep a layer of atomic hydrogen (which is an electrical insulator) over the cathodic areas. This can be accomplished by simultaneously keeping boiler water alkalinities in the prescribed range and eliminating dissolved oxygen from the feed water and boiler water. Low alkalinity permits corrosion to proceed by removing the protective layer of atomic hydrogen. For each molecule of hydrogen gas which escapes from a cathodic area an atom of iron must go into solution at the anodic area to repair the protective film. Acid corrosion, that caused by low alkalinity, may be identified by general etching of the water side surfaces and it may be accompanied by localized pitting.

If the boiler water alkalinity is too high, strong caustic concentrations may develop in the film in contact with the evaporative surfaces. Such strong caustic solutions can dissolve the protective oxide layer from the surface of the metal and permit continuous reaction of the metal with water. This process can cause severe furrowing and grooving in tubes where high evaporation rates establish a local, high concentration, alkaline film. Proper treatment is a choice of a mean between two extremes.

Dissolved oxygen accelerates electrolytic corrosion by combining with and removing the protective layer of atomic hydrogen from cathodic areas and thus renewing corrosion of iron in the anodic areas. Oxygen corrosion can be identified by the occurence of scattered, localized pits and by the absence of general

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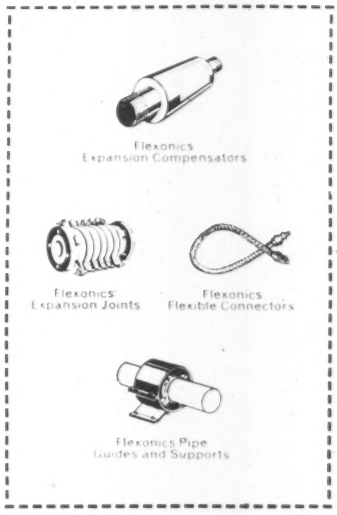


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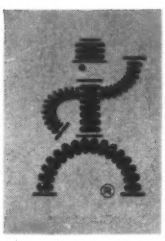

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## question of the month

*Continued*

corrosion in the intervening areas. Oxygen pitting is accelerated by an increase in temperature, dissolved oxygen, and acidity (decrease in alkalinity).

The normal introduction of feed water to the top drum of a steaming boiler usually reduces the dissolved oxygen to a tolerable residual, since the evolved steam scrubs the dissolved gasses away, but there is considerable evidence that traces of oxygen can cause serious pitting of fire row or stud wall tubes or of other relatively hot portions of the boilers.

Economizers, which operate at low temperatures and can provide no escape for the dissolved oxygen, are particularly vulnerable to corrosion.

Aerated feed water is the principal source of oxygen contamination of boiler water. Atmospheric oxygen may be drawn into a boiler secured at steaming level and permitted to cool. Air will dissolve readily in feed water, and if it is not removed by the condensers or deaerating feed tanks, it passes on to the economizer and generating tube next.

It is imperative that the dissolved oxygen content of the feed water be reduced to the lowest attainable level before it leaves the deaerating feed tank and that the feed water be protected against air in leakage during its travel through the suction lines. It is also imperative to take every precaution to secure a boiler so as to prevent oxygen from entering the boiler while it is cooling and while cold.

ROBERT S. FREDERICKS
*Project Engineer*
*Puget Sound Naval Shipyard*

### Traditional Powdered Zinc-Kerosene Mixture Gives Good Protection

THERE are a number of metal coatings available which can be used with success. One that we have used for heating systems that operate above 200 F is particularly suitable for the internal protection of boiler tubes and drums. Another type of coating has been used with success in hot water heating systems that operate between 160 and 200 F.

A simple old time formula which is frequently used with considerable success on steam boilers is a mixture of powdered zinc and kerosene mixed to a consistency of paint. If this mixture is applied about twice a year, it should give good protection. Water treatment is, of course, also recommended.

E. C. HACH
*Director of Maintenance*
*Mayview State Hospital*
*Department of Public Welfare*
*Commonwealth of Pennsylvania*

READER ASKS—

### "How Much Load From Vapor Infiltration?"

"My problem is primarily concerned with moisture vapor infiltration and/or transmission through cracks and door openings. Our operations include research with hazardous, explosive materials and must be conducted in an atmosphere of low moisture content (about 20 grains per lb of dry air). Due to their character, these materials must be isolated in small cells having one light or frangible wall and roof for explosion relief.

"Recirculation is prohibited, due to the same hazards. Therefore it is desirable to keep the number of air changes to a minimum for the sake of economy. Exhaust fans and hoods are utilized which remove approximately 90 percent of the supply air. The doors, which are the only means of access, are located in the relief wall and constitute about 16 percent of the perimeter of the cell walls.

"My question is in two parts: (1) How much latent and sensible load should be included per ft of crack and per door opening with outside design of 100 F dry bulb, 81 F wet bulb, and with 15 mph wind? (2) Can the water vapor infiltration through the cracks be prevented by a positive air pressure within the space?

"It seems entirely possible, with the nearly 10 in. of water gage difference in vapor pressure between the outside and inside, that water vapor might be coming in while air could be traveling in the same direction along the same path.

"I would also appreciate knowing of any good reference material concerning the above problem, as well as the fundamentals and behavior of the mixing of gases, partial pressures, and vapor pressures."—M.B.M.

• *YOU ARE INVITED to contribute a question for publication or an answer to a published question. Write: The Editors, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.*

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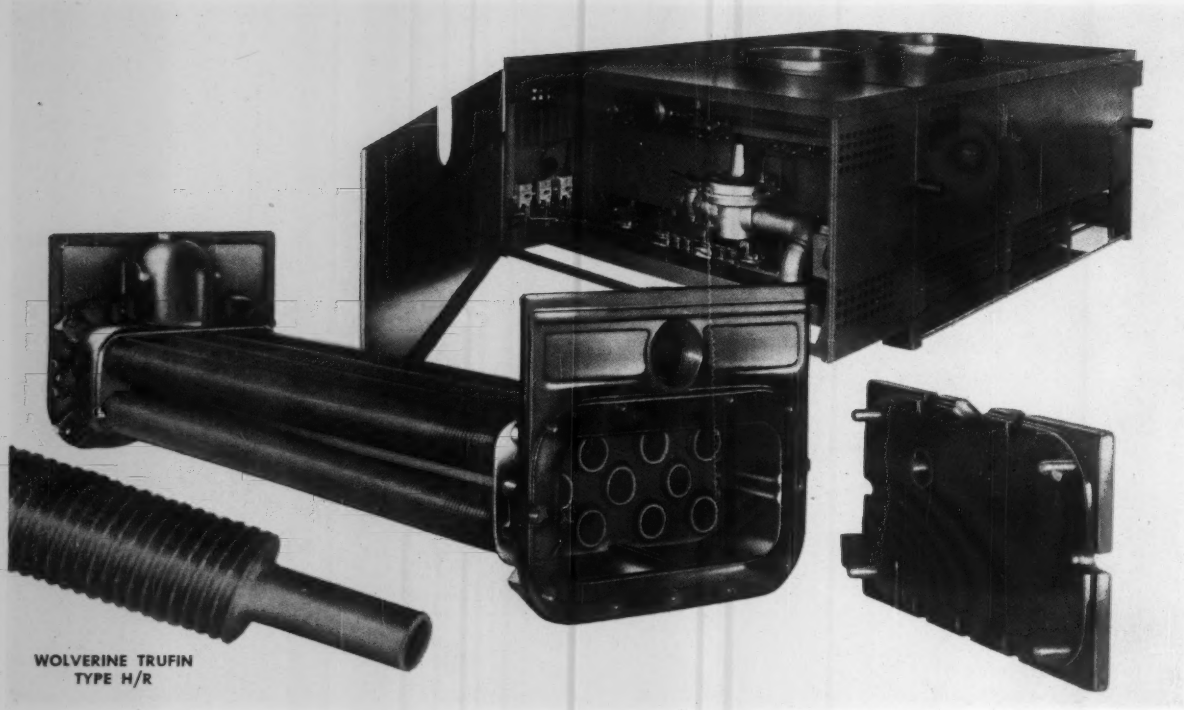

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Like all manufacturers, designers of equipment for the swimming pool industry want maximum capacity from components of the smallest possible size.

That's why Laars Engineers, Inc., North Hollywood, California, used Wolverine Trufin Type H/R tube when they designed the world's largest capacity swimming pool heater.

Simply by using integrally finned Trufin Type H/R, Laars engineers were able to reduce unit size by a whopping 291%. The heater, with a rating of more than 170 boiler horsepower, has a 7,125,000 BTU input and an output of 5,700,000 BTU's. It is only *195* cubic feet in size. If tubed with bare tube, a unit of similar capacity and horsepower would require approximately *670* cubic feet.

At Laars Engineers, Inc., however, Trufin's amazing ability to pack more heat transfer surface into less space has been well known for a long, long time. Tens of thousands of Trufin-tubed Laars water heaters and boilers are daily giving outstanding performance, both in the United States and throughout the world.

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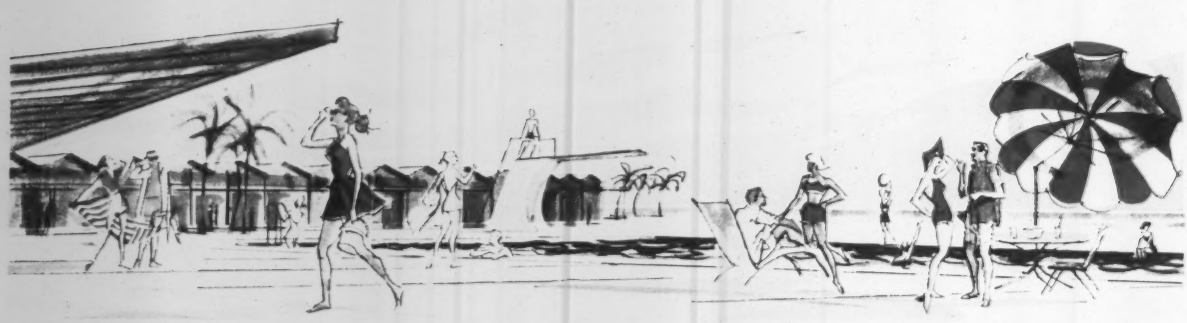

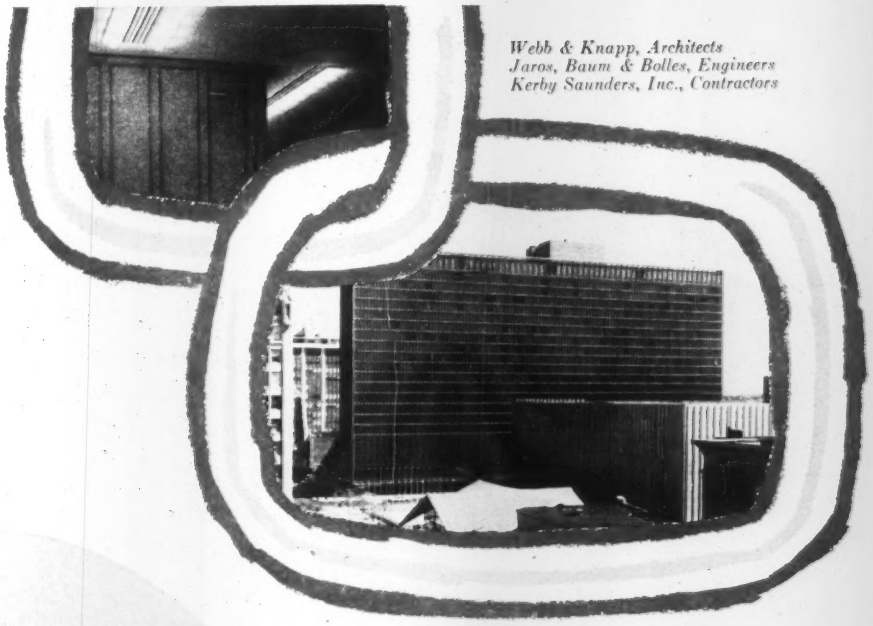

*Webb & Knapp, Architects*
*Jaros, Baum & Bolles, Engineers*
*Kerby Saunders, Inc., Contractors*

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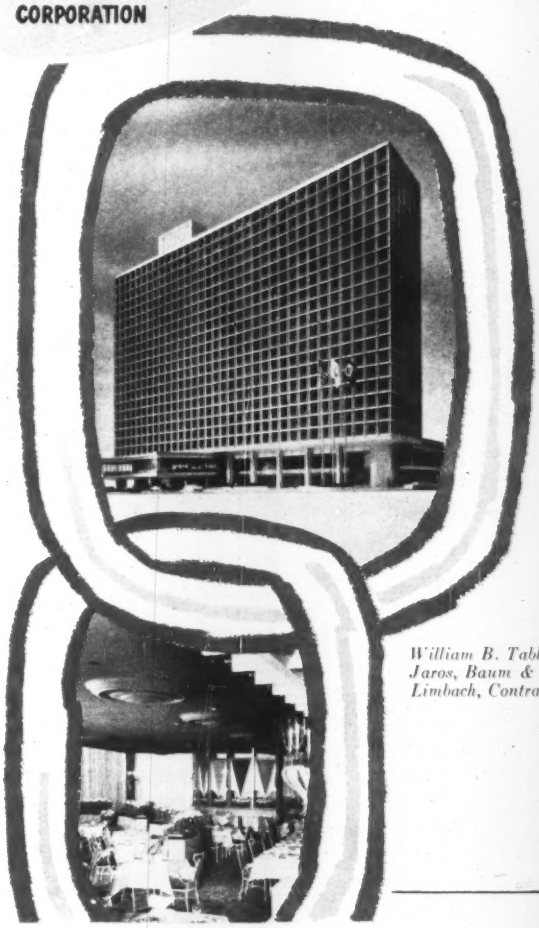

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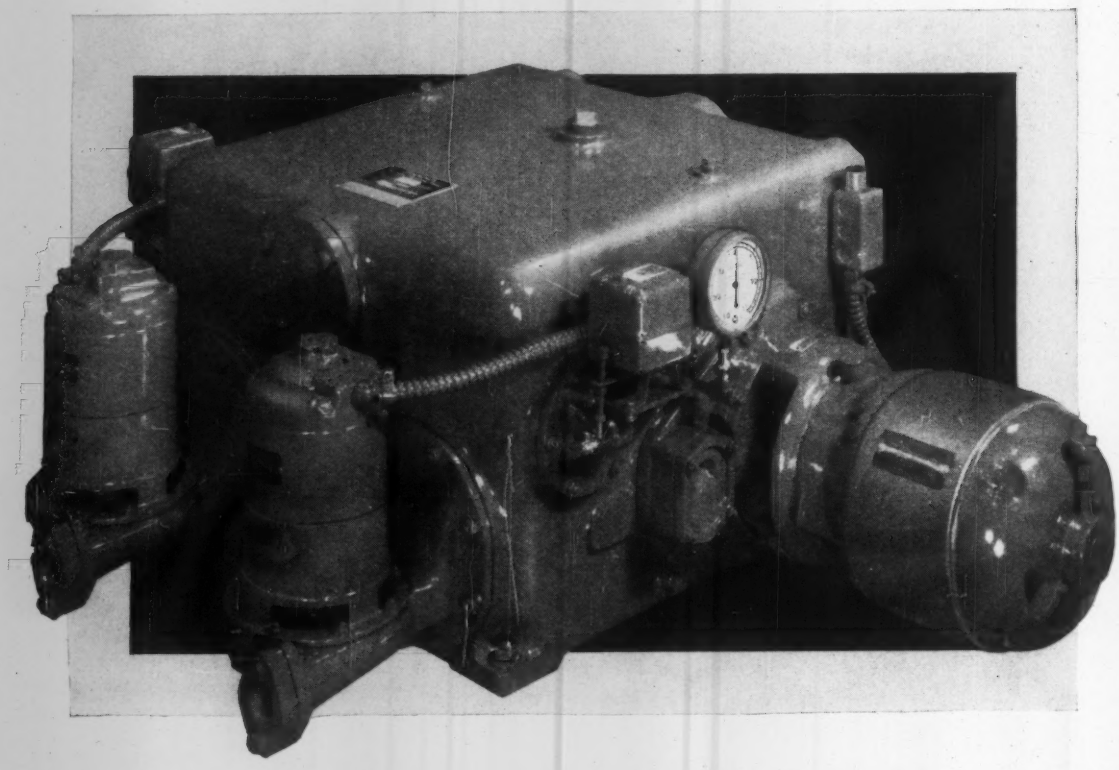

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These pumps possess many other features which permit a more efficient utilization of fuel and minimum use of electric power. Low, low, returns reduce installation costs and usually eliminate putting the pump in a pit. Simplicity and efficient operation reduce supervision and maintenance costs. Information regarding this new heating pump development is available immediately upon request.

- Increased air capacity induces rapid system response without wasteful overheating.
- Separate air and water pumps individually selected to meet actual job requirements.
- Control system that operates individual pumps only when needed.
- Flexibility permitting addition of radiation without changing basic pump installation.
- Low, low, return line connection.

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**• School building budgets are always limited at least to the extent that school authorities need to get a lot for their money. Since this is their due, a close consideration must be made of the exact requirements for a school building heating and ventilating system. Expected enrollments, reflected in state ventilating codes, extra-curricular activities that will include use of school facilities, the need for a variety of different services from the same central plant, and, of prime importance today, the possibility of future expansion — all are factors which materially affect the choice of the ideal heating plant. How such considerations were melded into an economical installation for a campus plan school is reported in this article.**

**Mr. Tower is a registered professional engineer in the State of Pennsylvania.**

# Double Loop Steam System Heats High School Campus

## . . . proves flexible, efficient

By ELWOOD S. TOWER
Consulting Engineer

IN SELECTING heating and ventilating systems for school buildings, a number of basic factors must be evaluated by school boards or comparable authorities and by the architects and engineers. Such considerations as initial costs, operating costs, and ventilating requirements of state codes are quite fundamental.

But many other factors affect the final decision as to the type of heating and ventilating that should be installed. A case in point is a new $3,491,000 campus-type senior high school in Bethel Park, Pennsylvania, a suburb of Pittsburgh.

### List Specialized Requirements

Among the "extra" problems faced by the Bethel Borough School Authority; the architect, Altenhof and Bown (AIA); and the author, who was mechanical engineer for the project, were these:

1) The heating and ventilating system had to be designed to serve each of seven separate buildings that eventually will comprise the total school plant occupying some 40 acres in the residential community. Total enrollment is expected to reach 2000 within the next 10 years.

2) Two of the structures are used the year-round for community functions as well as for school activities. Many functions are held during evening hours. Thus, the heating-ventilating system had to be flexible enough to handle requirements in buildings occupied during non-school hours, and to maintain only standby heat in the others, then carry the full load from all buildings during the school day.

3) The heating-ventilating system had to be capable of being expanded to handle three additional buildings which will be constructed within the next few years.

# Efficient Campus Heating

4) To conserve costs, both in initial equipment and in operations, the heating system had to be designed to heat domestic water and to provide a number of other hot water services in the buildings, including swimming pool, laundry, and cafeteria kitchen.

### Choose Double Loop Steam System

After studying a dozen different types of design, the architects and the engineer decided that the one which could meet all of the specifications — and still be within economic bounds — was a double-loop, high pressure-low pressure steam system fed by a gas-fired central boiler. The two-loop arrangement permits supplying high pressure steam to one group of buildings while the steam supply to the other group is valved off.

Automatic controls in the central boiler house and pneumatic controls throughout the entire system give it a high degree of flexibility. It is possible with this system to maintain design temperature, when required, in only one room in one building while all other rooms are at a standby temperature of between 57 and 60 F.

High pressure steam (125 psi) from the underground mains is reduced to medium (35 psi) and low pressure (between 5 and 10 psi) in each building. This obviously required additional reducing valves and accessory equipment. But the cost of the additional pressure-reducing equipment was lower than the cost would have been to pipe the required volume of low pressure steam from the boiler house to all buildings.

Pipe mains up to 16 in. in diameter would have been needed for a low pressure system. With high pressure steam, the pipe mains are mostly 3 in. and 4 in. with one run of 6 in. diameter piping.

### Experience Proves Economy

The economy of the heating system was apparent during the 1959-60 heating season. According to the gas utility serving the school, gas usage for space heating, cooking, water heating (including the swimming pool), incineration, laboratory, and domestic science, amounted to 8429 Mcf from October, 1959 through May, 1960.

At an average rate of 73.6 cents per Mcf, this amounted to $6200. The auditorium and physical education buildings, however, were not completed until January and March. However they were heated during the final construction phases from October on.

Considering the total design heat loss of 17,280,000 Btu per hr for all the occupied buildings, and in view of the fact that the auditorium-cafeteria and physical education buildings were used for community affairs many evenings after their completion, the fuel consumption is considered to be economical.

### Campus Will Have Seven Units

In the campus layout of Bethel Senior High School, provisions are made for three one-story academic buildings, one each for grades 10, 11, and 12. Two of the three units were completed and occupied last fall by the current enrollment of 1000 students. Each of these units has about 28,500 sq ft of floor area. The third will be built later.

Complete facilities for each grade are housed in the Academic Units, including classrooms, laboratories, offices, locker rooms, and separate rooms for such activities as photography, audio-visual, remedial instruction, and counseling.

### Separate Buildings Aid Learning

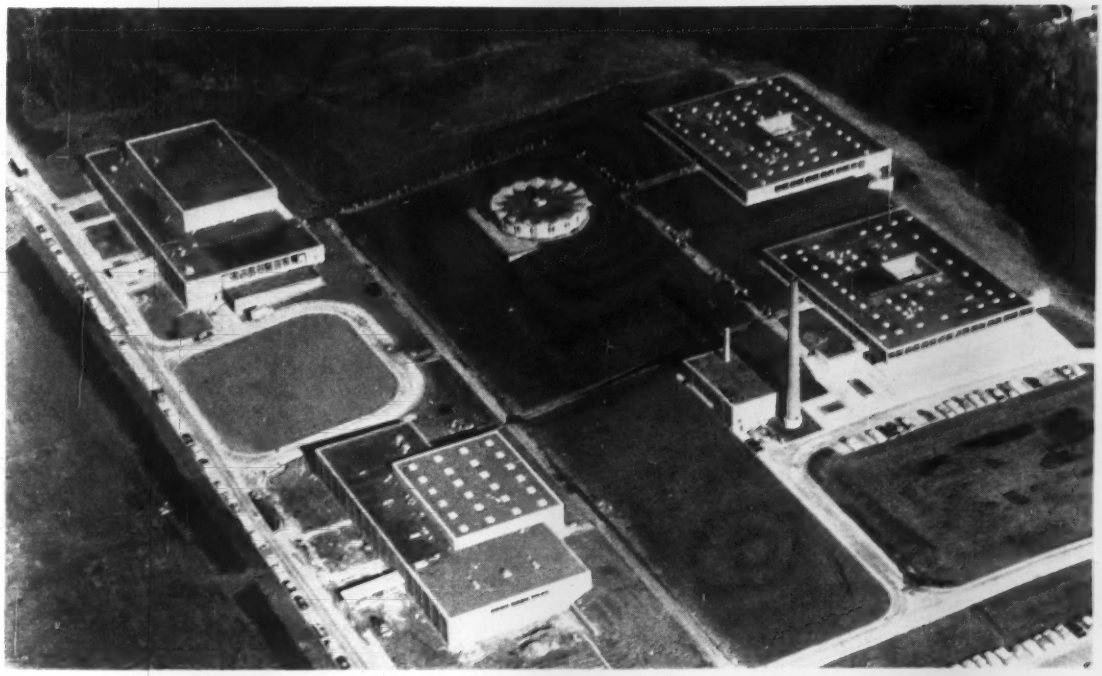
Described as the "plateau" method, the housing of each grade in a separate and complete unit permits students in the same age group to fraternize. Each Academic Unit has its own student "commons" or lounge area opening into a central outdoor courtyard. In this area, about 1500 sq ft, students may study, attend art classes, or participate in discussion groups.

The physical education building is a two-story structure containing about 36,000 sq ft, of floor area. It houses the main gymnasium, auxiliary gyms, wrestling room, swimming pool, lockers, showers, and miscellaneous other facilities.

The auditorium-cafeteria building contains some 46,500 sq ft of area. The auditorium proper has a seating capacity for 1500. In addition to the cafeteria, this building houses an arts and crafts center, home economics and domestic science facilities, band, orchestra, and chorus practice rooms, and dressing rooms. In the center of the campus is the library, a double-hexagon shaped structure containing 5110 sq ft.

The boiler house is approximately 50 ft by 80 ft in size. Besides the boilers and equipment, it contains a gas-fired incinerator, electrical vault, and office.

Still to be constructed are the third Academic Unit, an administration building, and an industrial arts building.



CAMPUS TYPE high school in Bethel Park, Pa. occupies 40 acres, uses central steam plant to supply heating and ventilating units in each building. Two academic units are at right in photo, with physical education building and auditorium-cafeteria at left, circular library in center

All buildings are of contemporary architectural design with structural steel frames. Three types of curtain walls are used: glass in aluminum frames, red brick, and pre-cast concrete slabs with special mosaic-like finish. All classrooms in the Academic Units have generous glass areas, extending from sill line to full ceiling height. The library is of unusual design, about 80 ft in diameter, with the roof pitched high at 16 points to permit clerestory lighting.

In the heating-ventilating system layout, all piping was designed and all equipment was sized to handle future requirements for the three additional structures. About 27 percent more area will be added to the present total of 169,800 sq ft. Heat losses for the additional areas were estimated at 4,800,000 Btu per hr. Existing steam mains are blanked off so connections can be made into each of the new structures.

### Consider Separated Boiler Plants

One type of heating-ventilating system considered during preliminary studies was a separate boiler in each building. But the additional expense of stacks and equipment ruled out this idea. An electrical resistance heating system was not given serious consideration due to the additional insulation that would have to be installed and to the cost of operating such systems. It was estimated that for this installation the use of electricity instead of gas as a fuel would cost five or six times more.

On the basis of comparative cost studies, it was decided to use gas as fuel for the main boiler, as well as for a smaller boiler for spring and summer heating requirements and for summer water heating. A second main boiler, however, was installed as a standby unit and was equipped for coal stoker firing.

### Installation Costs Meet Average

Despite the fact that the entire heating-ventilating system is oversized to handle future needs, and considering the additional cost of the third boiler with stoker and ash-removal equipment, the heating contract was bid at only 15.5 percent of the total cost of the school. Also included in the heating contract were such additional items as steam piping and valves for the swimming pool water heater, steam cooking equipment in the cafeteria kitchen, domestic water heaters, and steam laundry equipment. In this area, 15 percent is about the average price today for installing a heating system in a single building, multi-story school, with far fewer heating problems.

Low bidder for the heating contract was the Wayne Crouse Co. The highest of three bids received was only 3½ percent more than the lowest, an indication of how closely the job was planned.

The two main units are 100,000 sq ft EDR (24

# Efficient Campus Heating

million Btu per hr output) water tube boilers. The smaller is a 20,000 sq ft EDR (4.8 million Btu per hr) unit. One of the two large boilers, fired with two gas burners, handles the entire high pressure steam load during the heating season. The small boiler, also equipped with a gas burner, is used during non-heating months for domestic hot water requirements and in late spring and early fall for both heating and hot water.

In a test on the gas-fired main boiler last March, its efficiency was measured at 77 percent when producing 30,000 lb of steam per hr, showing it to be entirely adequate to handle the entire load.

### Double Loop System Installed Underground

Steam at 125 psi is piped in one loop to serve the two Academic Units and the library. Another loop carries steam to the auditorium-cafeteria and the physical education buildings. All high pressure steam piping, along with high pressure drip and pump discharge lines are underground in insulating concrete. In fact, the entire campus is free of any piping or wiring above ground.

Low pressure steam (5 to 10 psi) is distributed from reducing stations in Academic Units by piping in tunnels under the perimeter of each building. Steam pressure is reduced in two stages so medium pressure steam (35 psi) can be taken off to serve the water heating equipment.

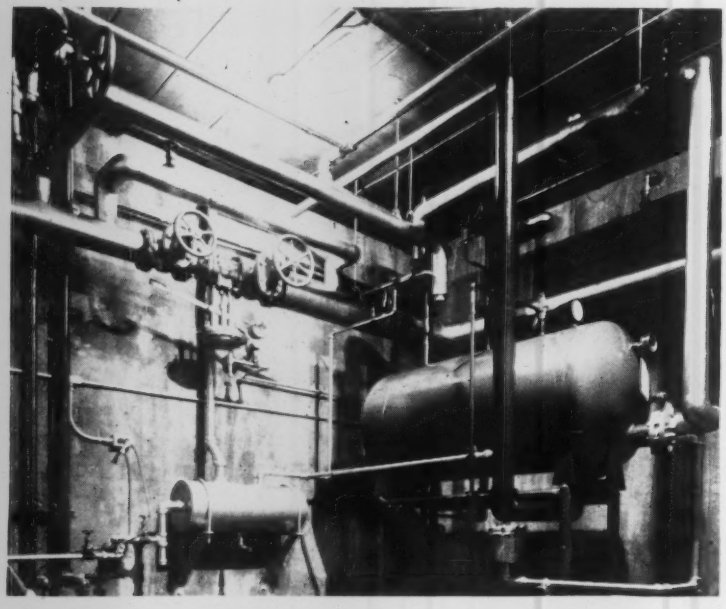
Steam is fed from the mains through vertical stubs to the heating and ventilating units in each room. All regular classrooms have outside window exposure. Classrooms are equipped with unit ventilators and finned tube sill line radiation units. Sill line heaters "blanket" every linear ft of window to minimize drafts and prevent condensation. Ventilators take their outdoor air supply directly from the outside through louvered wall openings. Each ventilator is sized to handle the Pennsylvania State Code requirements for classroom air changes, a minimum of 10 cfm of outside air per student.

The average classroom ventilator unit handles 1250 cfm of air and automatically blends outside and recirculated air.

### Vent Exhaust Through Corridors

Exhaust air from classrooms is vented to the corridors through a 3 in. space between the door and floor. From the corridors, it is picked up at duct openings and vented outside through continuous type roof ventilators. Some air is removed also by the power exhaust fans in lavatories, locker rooms, and such areas as the photographic dark room and chemistry laboratory.

All rooms are equipped with two-temperature type thermostats, which are changed automatically from "day" to "night" settings by adjusting the supply



MECHANICAL ROOM for each building receives high pressure steam from central plant. Pressure reducing valve for steam line to classroom units can be seen near center of photo at left. 125 psi steam is reduced to 35 psi for heating domestic hot water, and to 5 psi for comfort heating

air pressure in the pneumatic control system at the boiler house. However, with steam in the system, any one room in any building can be heated to desired temperature at any time of the day or night by manually resetting pushbuttons on the thermostat.

Thus, if a night meeting or a class is to be held in one room, it can be heated without heating the others.

Normal room temperature of classrooms is maintained at 70 to 74 F for occupancy periods, and 60 F or lower for non-occupancy.

### Large Areas Pose Problems

Heating the auditorium-cafeteria and physical education buildings posed greater challenges to the designers.

The auditorium proper, with its high ceiling and nearly 15,000 sq ft of uninterrupted floor area, is heated and ventilated by two large unit ventilators. They discharge a blend of outside and recirculated air into an overhead duct system behind the auditorium ceiling. A total of some 30,000 cfm is discharged into the area through 18 rectangular diffusers in the ceiling; into the 43 by 90 ft stage area through 10 overhead diffusers; and into the lobby through 10 ceiling diffusers. The units can be operated with 100 percent outside air with the steam supply shut off to ventilate the area in warm weather.

The two unit ventilators are installed on either side of the projection room of the auditorium. They take outdoor air directly from the outside through screened and louvered wall openings with motorized dampers. Outdoor air is blended in the units with air recirculated from the rear of the auditorium. Two grilled openings at the front of the auditorium carry exhaust air through ducts to continuous type roof ventilators.

### Music Rooms Have Sound Traps

In the ensemble practice rooms, which are heated and ventilated by branch air supply ducts, sound traps have been installed in the ductwork to prevent the transmission of sound between the rooms served by the system.

In the main gymnasium, with 10,885 sq ft of floor area, three overhead unit ventilators are used. They are positioned to take care of three sections of the area which may be separated by folding doors. Each unit handles 6000 cfm of outdoor and recirculated air. Along the exterior walls of the gym, 16 sill line finned heaters also are installed well above the playing area. An auxiliary gym with 5300 sq ft of floor area is heated by one unit ventilator (6600 cfm) and wall-hung radiation units.

An AAU competition size swimming pool is located in a separate part of the physical education building

BUILDINGS AND GROUNDS superintendent R. R. Fisher shows central control panel for clock-programmed temperature control system

with 6330 sq ft of floor area. Condensation on windows along one wall of the pool area was a problem solved by installing overhead diffusers to discharge a continuous curtain of warm air down that side of the building.

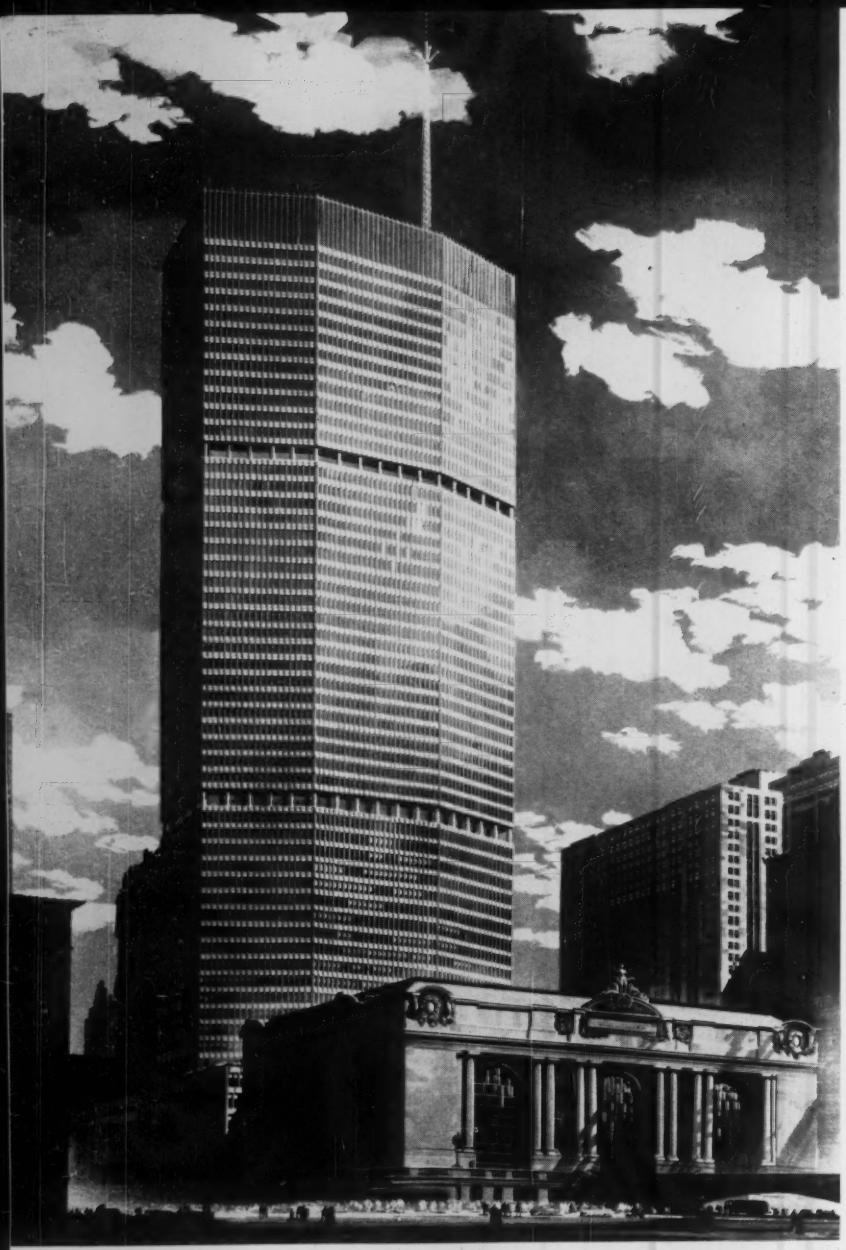
These diffusers are supplied from a duct system covering the entire ceiling of the pool area. One unit ventilator feeds the system with outdoor and recirculated air at 17,000 cfm. Twelve finned radiation units also are installed in the pool area.

Medium pressure steam is the heating medium for an instantaneous water heater, designed to handle a temperature rise of 10 F in 400 gpm of water through the swimming pool filtration system.

The incinerator for the school is in the boiler house. With a capacity of 400 lb per hr, the main combustion chamber is fired with a 500,000 Btu per hr blast type gas burner. The rear chamber is equipped with a 140,000 Btu per hr luminous type gas burner for smoke and odor elimination.

### Design Balances Cost Factors

Design of the gas-fired, high pressure-low pressure heating and ventilating system for this campus-type high school achieves a balance between initial equipment and installation costs, fuel economy, control flexibility, system expandability, multiple uses for the steam generated, maintenance of comfort levels in all areas, and compliance with state code requirements for classroom ventilation. ∓



PAN AM BUILDING will straddle railway tracks and platforms of New York's Grand Central terminal. Horizontal and vertical louvers for outside air intake to perimeter and interior air conditioning systems are located as shown on page opposite

# Mechanical Complements

**• Keeping pace with, or a little ahead of, the modern architectural trends toward greater utility and beauty demands the best from the mechanical design engineer for big building air conditioning. This article reports how imaginative mechanical design met the test on one of our most impressive new structures — the new Pan Am building (ex Grand Central City) in New York. An elongated octagonal shape and recessed equipment floors for the 49 story tower allowed designers to integrate exterior louvers for perimeter induction units and interior systems into the building's facade, thus preserving architectural harmony. Primary air risers are located in shafts within the structure's core, while secondary water risers adjoin structural columns.**

THE SKYSCRAPER building boom on New York's Manhattan Island has produced some unusual problems for engineers connected with the design and installation of the air conditioning systems needed to match the functional usefulness of the new structures.

Today's architecture places certain demands of location and performance on mechanical equipment that were not encountered in the days when building design was more nearly "standard."

### Start Biggest Office Unit

What may be the largest commercial office building in this country is being erected immediately north of the Grand Central rail terminal in New York. Originally named Grand Central City, the structure will now be called the Pan Am Building in deference to Pan American World Airways, which will occupy 15 floors totaling 613 thousand sq ft. The 58 story building will rise 800 ft, and will provide a net rentable floor area of some 2.4 million sq ft.

The old four and five story Grand Central Terminal building is being demolished to make room for the new giant. Since the location is directly over the railway tracks and platforms, however, the

By LEWIS SMITH

# Design Architectural Features

building will have no basements, nor any space below ground level for equipment.

### Plan Octagonal Tower

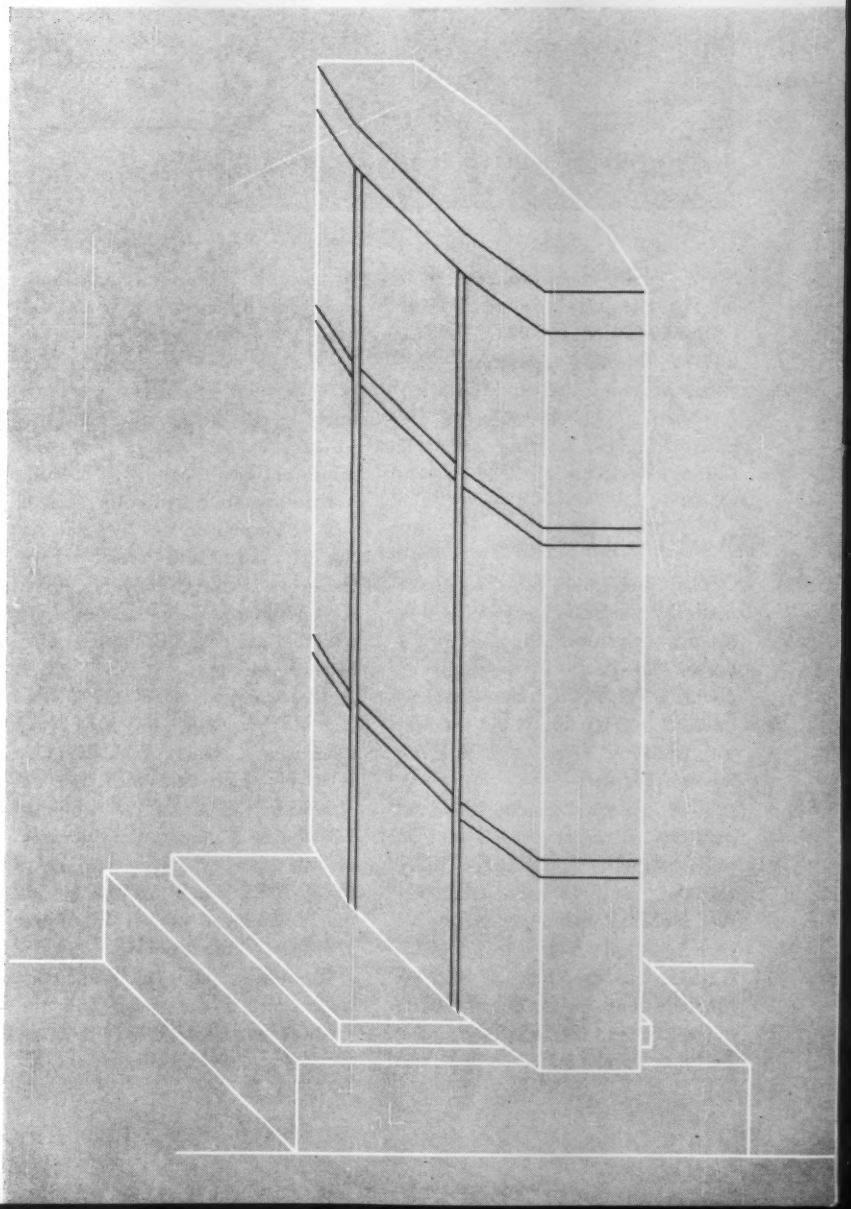
The first seven floors will cover an area measuring 300 ft east and west along 45th St., and 373 ft on the opposing axis along Vanderbilt Ave.. The eighth and ninth floors will be set back and topped by a 19 story tower.

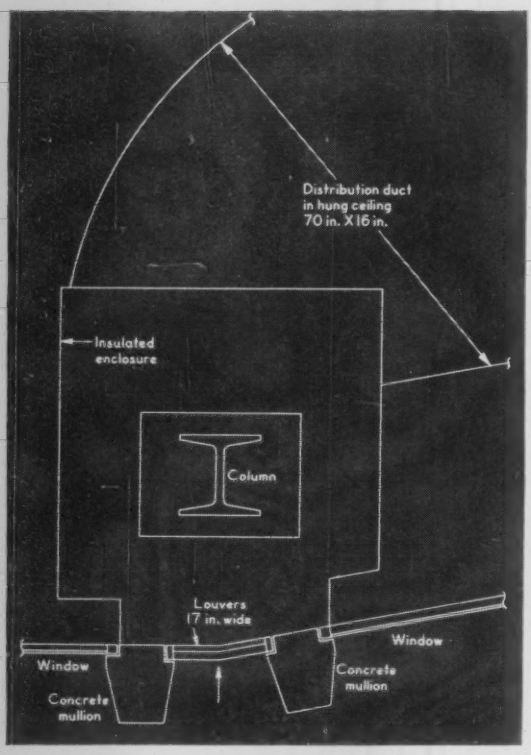
The architectural and structural features of this tower had a profound effect upon the design of the air conditioning system. Instead of the usual rectangle, the tower will be constructed to an elongated octagonal shape. Such a design was selected in order to break what otherwise would have been sheer north and south faces up to 310 ft wide and some 700 ft high.

The division of these walls produces a three-facet exposure which will be more pleasing to the eye and also allow for better arrangement of the spaces at the east and west extremities, beyond the core of the building.

### Separate Equipment Floors

To further relieve the immensity of appearance, the 21st and 46th floor facades are recessed.






FOUR CORNERS of building's octagonal shape are obtuse angles, resulting in narrow space between concrete mullions at these points. Designers took advantage of two of these spaces to install continuous vertical intake louvers which provide outside air to interior areas of tower by means of two blowers on each floor. Louvers on opposite face will serve as exhaust outlets

Since these areas are designed mainly as space for mechanical equipment, such a device also aids air conditioning operation. The recess provides a shielded location for what might otherwise be obtrusive louvers for the air conditioning systems.

### Work From Perimeter

The first and basic decision made by the design engineers was to air condition the building's perimeter spaces to a depth of about 15 ft by means of an induction unit system. Conventional air handling systems will serve the interior areas.

Investigation revealed that the primary air risers needed for the induction units would be too bulky for the usual location alongside the building columns, owing to certain unique features of the design. It was therefore determined to place four risers, one for each exposure, in the shafts of the building core, and to connect the risers to the individual units along each wall by means of horizontal branch conduits small enough to be located above the hung ceiling at each floor level. These branch ducts had to be of minimum size so as not to interfere with the minimum head room of 8 ft 8 in.

Primary air fans for the system will be located on the roof and on the 21st and 46th floors, where the necessary large louvers can be set on the recessed exterior walls without marring the appearance of the building.

Secondary water for the perimeter units will be furnished from risers which, due to their relatively small size, can be placed alongside the structural columns. Circulating pumps will be located on the roof and two equipment floors. This layout for the perimeter system will permit individual room temperature control.

Because of the physical configuration of the space and the purposes for which it is to be used, the designers decided that the interior areas of the tower floors should be served by two fan systems on each level, one at each end of the center core.

### Use Continuous Louvers

The octagonal shape of the tower results in a narrow space between the concrete mullions of the tower section at each of the four obtuse angles. These spaces will be utilized for continuous vertical louvers, which will serve as air intakes and exhaust ports for the relatively small fan systems.

The louvers are not only unobtrusive but may actually enhance the building's appearance.

North side louvers provide air inlet, while those on the opposite face are used as outlets. This procedure takes advantage of the prevailing wind direction.

Air distributon on each floor is through single ducts, with return ducts in the hung ceilings and reheaters as required.

The lower nine floors of the structure are treated in a similar manner but with some variations. Again because of the architectural concept, the eighth and ninth floors (those which are set back) each contain two fan rooms used for conditioning of the interior spaces. Four fan rooms on each level are used for the fourth to the seventh floors.

Air supply is to be obtained from vertical shafts which originate alongside the elevator rooms on the ninth floor roof. Such shafts also serve as exhaust outlets. This method applies to all but the south exposure, on which air is obtained through intake louvers in the exterior wall of the ninth floor and exhausted to the garage section. This parking area includes space on six levels and is open to the atmosphere at either end.

Primary air for the perimeter units in the entire base section is supplied from the equipment on the 21st level. Risers for the eighth and ninth stories are within the core as they are for the tower. Risers serving the third to the seventh levels, however, are small enough to be located alongside the structural columns.

Horizontal distribution ducts within the ceiling of the second story serve the first two levels. Thus, vertical risers to the upper floors are kept small enough to allow placement alongside the columns.

Secondary water for the perimeter units of the entire building is circulated through a two-pipe upfeed system at the columns, supplied by water from a riser within the core of the building. The secondary water sources are on the 21st, 46th, and 58th floors.

All chilled water equipment will be placed on the roof of the tower. Cooling towers will also be located at this level. Three steam turbine-drive centrifugal compressors will provide a total cooling capacity of 10,000 tons, and will operate on district steam.

Architects for the project are Emery Roth & Sons. Walter Gropius and Pietro Belluschi are design consultants.

Jaros, Baum & Bolles serve as consulting mechanical and electrical engineers, and the mechanical contractor is the Raisler Corp. ‡

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***Sam Lewis says:***

## "It Took Months To Discover This Unfortunate Mis-connection"

HERE is a tragedy. The cost of correcting the errors described here has been politically disastrous to a certain Board of Education.

The story concerns a school heating plant which uses mechanically-circulated hot water, but I make no complaint against the use of that type of system as such.

In this plant the temperature distribution was balanced by having the first heat transmitter, that one nearest the boiler, connected in such manner that the slightly cooled water leaving it could return to the boiler only through certain pipes, the resistance of which tended to equalize the heat distribution from all heat transmitters.

These primary water mains convey heat to out-lying converters in order to heat domestic water for lavatories and for a kitchen. Near each converter there is a local thermostatic valve to select just enough and no more of the primary hot water required to heat the domestic water to temperatures from 140 to 180 F.

The somewhat cooler primary water is sent back to the boiler. However, there are several ventilating systems for warming large quantities of very cold outside air to 135 F; and for each such system a local three-way water valve and an electric circulating pump is installed.

This valve, controlled by a heat-sensitive device, diverted just enough primary water, along with just enough slightly cooled recirculated water, to the air-heating coils. A pump returns the water to the boiler.

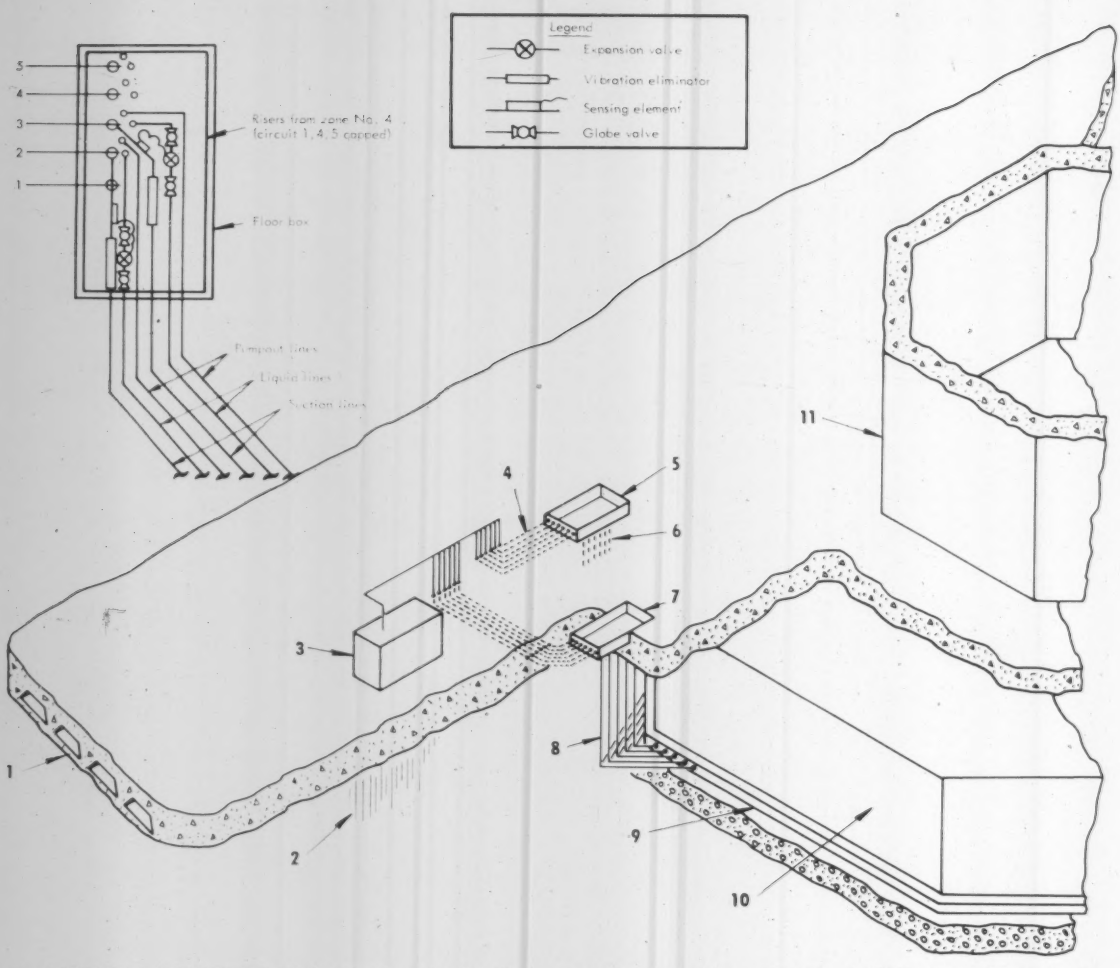
Someone, however, had connected this considerably-cooled primary water from the return pump to the primary water main. It took months before the local authorities discovered this unfortunate mis-connection and commenced to obtain domestic hot water at adequate temperature.

This school has many important rooms, the air supply for which is delivered through a sieve-like ceiling. The air exhaust outlet for each room was also in the ceiling.

Thus the entering air, whenever the room was relatively cool, short-circuited directly from inlet to outlet, and did not circulate effectively.

The warmer the room became, the greater was the tendency for the air to short-circuit and the more difficult it became to maintain comfort.

The school board paid me after I balanced the hot water distribution and after I changed the exhaust outlet grilles in the classrooms from ceiling to side wall at the floor. ‡




**1** ANTENNA FOUNDATION for Arctic radar installation rests on ground kept permanently frozen by refrigerant piping system. Isometric shows 1) slab ventilation passages for building floor, 2) non-frost susceptible material beneath slab, 3) condensing unit serving ½ of system, 4) piping in finished floor, 5) floor box for zone No. 4, 6) refrigerant risers to foundation, 7) floor box for zone No. 1, 8) zone 1 refrigerant risers, 9) 6 in. evaporator piping slab, 10) 8 ft thick octagonal pedestal, and 11) radar antenna tower. Inset shows details of floor box for one zone, with refrigerant riser expansion valves, pressure sensing elements

# Refrigerant Piping System "Supports" Arctic Radar Sites

By JAMES A. FIFE
Mechanical Engineer
Metcalf & Eddy, Engineers

THE BMEWS (Ballistic Missile Early Warning System) project under construction near Thule, Greenland will provide the U. S. Air Force with ultra long range radar detection capabilities. Because of the nature of the locale and the extreme climatic conditions encountered, work on this project has resulted in the development of a number of unprecedented engineering methods.

**• The United States is constructing a peripheral ballistic missile early warning system (BMEWS) consisting of a series of huge long range radar installations. Movable 225 ton radar antenna must be founded on extremely rigid bases. North of the Arctic Circle, permanently frozen ground can support the concrete foundations. Heat of hydration from the setting concrete in massive pillars, plus building and equipment heat from the completed installation, however, can induce thawing and instability. To combat this two-fold problem, refrigerant piping is installed within the slab of the foundation itself. How this system is designed, installed, and tested is described in this article. This defense project has a 10 yr warranty on a piping system buried beneath 8 ft of concrete.**

**Mr. Fife is a graduate of the University of Louisville and is professionally registered in Massachusetts. He served as mechanical design supervisor for the project which he describes.**

All design and construction activities for the project are under the direction of the U. S. Army Corps of Engineers. Metcalf & Eddy, Engineers, have been engaged as architect-engineers for the project.

### Project Demanded New Methods

Although preceded by the mammoth engineering job represented by the development of the Thule Air Base, the BMEWS project presented problems not previously encountered.

Specifically, the requirements for foundation rigidity beneath certain radar facilities were such that no previous foundation designs could be used. The foundation problem at Thule — past and present — is one of compensating for or exploiting the peculiarities of "permafrost."

Permafrost, as the name implies, is permanently frozen ground, and is peculiar to the Arctic and Antarctic regions. At Thule, it extends to a depth of more than 1000 ft. A surface layer, however, thaws and freezes with the various seasons, and is referred to as the "active zone." The depth of the active zone may range from a few in. to several ft, depending upon the thermal conditions of the surface area involved.

### Permafrost Supports Heavy Loads

As long as permafrost is unthawed, it is capable of supporting heavy structural loads. Heat from buildings or other structures founded on permafrost, however, can induce thawing. Depending on the ice content of the ground, which may be as high as 50 percent or more, this thermal disturbance produces varying degrees of instability.

To counteract that phenomenon, a layer of non-frost-susceptible fill is usually placed between the building foundation and the permafrost, and air circulation through or under the floor system is provided to dissipate building heat.

Support of key radar equipment at Thule required concrete towers set on massive octagonal foundations, measuring 55 ft across the flats and 8 ft thick. The combined weight of the tower and foundation approximates 2400 tons.

### Extreme Rigidity Required

A high degree of rigidity within the foundations is required by the design criteria established for the radar system installation. Such rigidity is necessary to minimize backlash and vibration created by the starting and stopping of heavy moving parts of a 225 ton radar dish.

Investigation showed that only rock, soil cement, or permanently frozen saturated granular soil possess the specified rigidity. Only one of the three foundations at the Thule site could be extended to bed rock by means of a soil cement pad. For the remaining two towers, it was decided to provide a permanently frozen, saturated granular fill resting on the permafrost.

### Decision Posed Complex Problem

Here the foundation problem was far more complex than that encountered with any previous structures.

In addition to the usual thawing factors, another source of heat appeared. The setting concrete would produce heat of hydration, which, in foundations of this size and volume, would be of considerable proportions.

### Heat Must Be Dissipated

Consequently, some method had to be conceived by which this heat could be dissipated to prevent any thermal disturbance of the frozen saturated fill and permafrost below. At the same time, some pro-

53-2

vision had to be made for the elimination of heat developed from operations within the building following its completion. The usual provision for air circulation proved inadequate for this installation, which meant that a considerable quantity of heat would find its way down through the foundation to the supporting soil.

### Soil Engineers Provide Data

The firm of Haley & Aldrich, soil engineers, had been engaged as consultants to assist in the foundation design, and developed data relative to the heat of hydration from the setting concrete. Specifically, this data revealed the rates at which heat would be generated during successive time intervals after the concrete was poured.

Having been provided this data, we were still faced with the problem of determining the amount of heat that would be transferred or dissipated in all directions, being especially interested in that particular heat quantity which would be transferred downward into the subgrade. Once this heat load was determined, it would then be a matter of developing a method of dissipation. The same method also had to be feasible for dissipating building heat after the building was in operation.

### Data Shows Varying Rate Curve

The data developed showed that the heat of hydration of curing concrete increases from 0 to 3000 Btu per cu ft in the first 12 hrs after pouring. From 12 hrs to 72 hrs it would increase slightly to 3500 Btu per cu ft, and then gradually taper off to zero over the next 30 to 45 days (Fig. 2). The tower foundation used 740 cu yd of concrete.

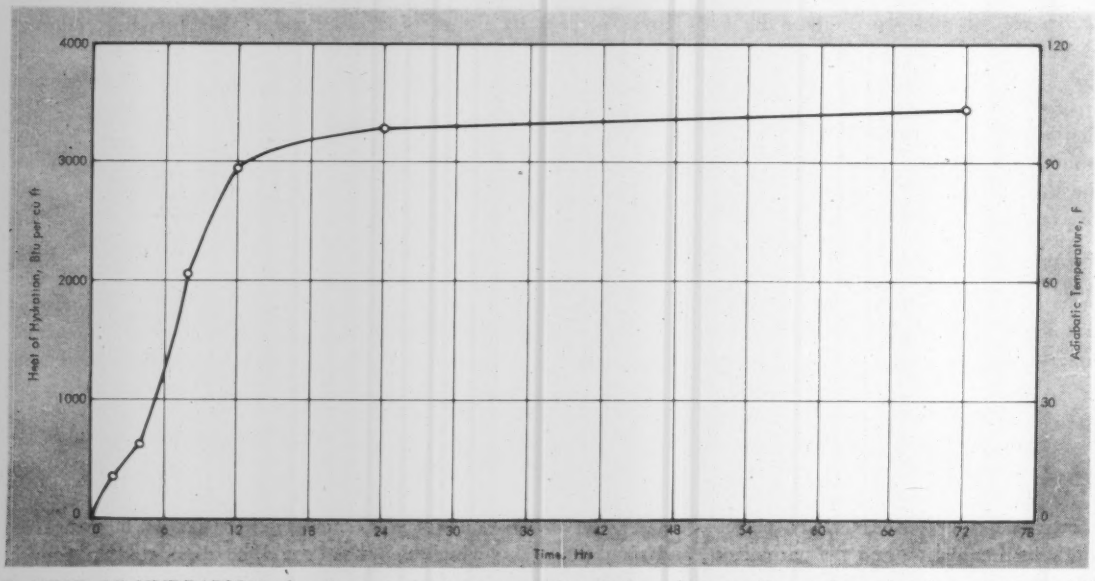
As mentioned previously, the foundations were to be supported on a perpetually frozen, saturated granular fill, and topped with a 9 in. layer of crushed rock, the latter to act as an insulation buffer zone. To maintain this foundation base in a stable condition, it was decided that a refrigerant piping system should be installed in the bottom of the concrete foundation.

### Two-Step Construction Planned

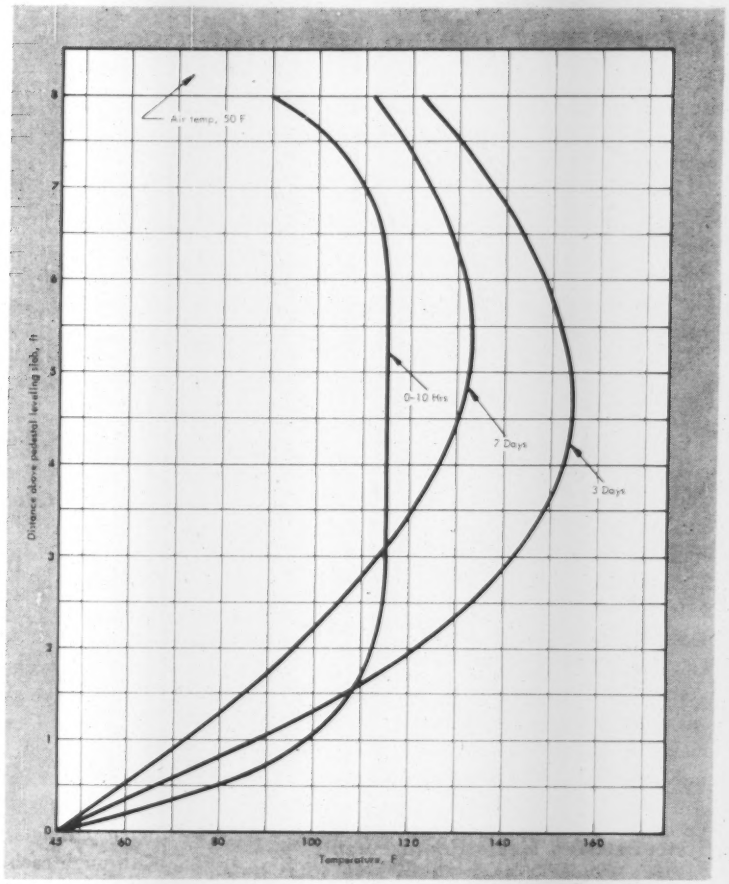
Construction of the foundation would proceed in two steps. The first would place a 6 in. leveling slab containing the refrigerant piping, and the second would complete the 8 ft thick octagonal foundation above.

Heat from the 6 in. slab was expected to thaw the crushed rock to a limited degree, but would not penetrate the frozen, saturated fill material. Initial testing of the refrigerant system would serve to refreeze the thawed portion of the crushed rock. Such testing or "prefreezing" would follow the placement and 3 day curing period of the slab.

The determination of the necessary capacity for the refrigerant system required the solution of a




**2** HEAT OF HYDRATION of curing concrete increases during 72 hrs after pouring as shown by above curve, would then taper off to zero during next 30 to 45 days. Temperature rise shown is theoretical, not measured, value




**3** TEMPERATURE distribution for Type III concrete in 8 ft thick octagonal pedestal is shown at right. Calculations were based on concrete placement rate and heat of hydration, revealed that peak load would occur at 10 to 15 hrs, thus giving advantage to use of high early strength concrete

transient heat transfer problem. Variables involved were the placement rate of the concrete, plus the heat input rate to the mass — the heat of hydration of concrete. Inasmuch as heat production would be most concentrated in the center of the foundation, horizontal heat transfer was neglected, and we confined our consideration to the vertical heat transfer to the air above and to the refrigerant piping system which serves as the evaporator.

The concrete placement rate was established at 40 cu yd per hr. Relative to the second part of the problem, two separate analyses were made; one each for Type I and Type III concretes.

### Calculate on Incremental Basis

Calculations were made to investigate the thermal behavior of incremental volumes of concrete, 1 sq ft in area and 1 in. thick, for each hour after beginning placement of the concrete. Placement of the entire 8 ft thick mass required about 16 hr. Our calculations were arranged in tabular form to facilitate the identification of the cooling load and maximum concrete temperatures.

A modified Schmidt method was used for determination of temperature, in order to include the heat of hydration input to the mass being considered. Thus, we proceeded on the basis of the following equation:

$$t'_1 = [t_o + (M\text{-}2)\ (t_1) + t_2]/M$$

*where*

$M = (\Delta x)^2/\propto \Delta\Theta = 2$

$t'_1$ = temperature at plane 1 after time lapse $\Delta\theta$

$t_o t, t_1, t^2$ = original temperatures at planes 0, 1, and 2

$\Delta x$ = thickness of the section through which heat is passing

$\propto$ = thermal diffusivity of material, $k/\rho Cp$

$\Delta\Theta$ = increment of time considered

### Establish Heat Transfer Rates

After concrete temperatures were established, heat transfer rates were established by the conventional equation:

$$q = (k/x)\ (A\Delta t)$$

The equation was modified as required for trans-

fer to either the evaporator below or to the air above. Fig. 3 shows the temperature distribution in the pedestal for Type III concrete.

Computations revealed that a peak load of 15 to 30 tons would be reached at 10 to 15 hours, and also that the construction advantage in using Type III (high early strength) concrete could be exploited. The initial heat gain with Type III concrete is greater than with Type I.

### Establish Temperature Limits

Certain temperature limits were also established as being essential to successful operation. These included a 30 F maximum at the interface of the 6 in. crushed rock and 6 in. slab; a 45 F minimum at the interface of the slab and 8 ft foundation; and a 50 F minimum for the ambient temperature about the 8 ft foundation. The latter two restrictions were necessary to ensure that the curing of the concrete would not be inhibited.

To control the ambient temperature, a heated tent was provided. (It was necessary to carry out this operation in subfreezing temperatures to prevent any possible thawing of the frozen saturated fill material.)

### System Design Meets Requirements

The refrigeration system selected to meet the above requirements (flexibility and precise control) was of a direct expansion type. This selection was based on the following considerations:

1) Any leaking gas would escape without damage to the frozen fill.
2) More flexibility was possible over a wide range of load capacity and temperature. This was extremely important due to the variation in load.
3) Less equipment was required.
4) Shorter delivery time of the system to the site was possible.
5) The refrigerant used would be free of toxic and corrosive effects associated with some other refrigerants.

The system designed for this unique application is divided into four zones, each serving one-quarter of the 55 ft octagon. There are five piping circuits per zone, with each circuit approximately 250 ft in length, and consisting of 1-5/8 in. OD copper tubing. All piping is contained within the 6 in. leveling slab. The tubing for each circuit is spaced approximately 6 in. on center, supported on T-bars approximately 2 in. above grade.

These T-bars are supported on adjustable chairs and the entire piping system is set level to ± 0.01 ft from a datum elevation. The five piping circuits are arranged in parallel, so that each circuit covers its particular quadrant evenly. The friction drop through each circuit is approximately equal. Circuits enter and leave the 6 in. slab at the same location, resulting in short expansion valve equalizer lines and capillary tubes.

## How Three-Phase Operation Proves Plan

Operation of the system was divided into three separate phases. Phase 1 involved the refreezing of the crushed rock after the 6 in. leveling slab had been placed and cured for three days. This phase utilized two 60 hp compressors installed at the level of the 6 in. slab, with each connected to two zones of evaporator coils. Phase 1 covered the period from initial testing of the system until approximately three days after placement of the 8 ft thick foundation.

### Phase Two Completes Heat Dissipation

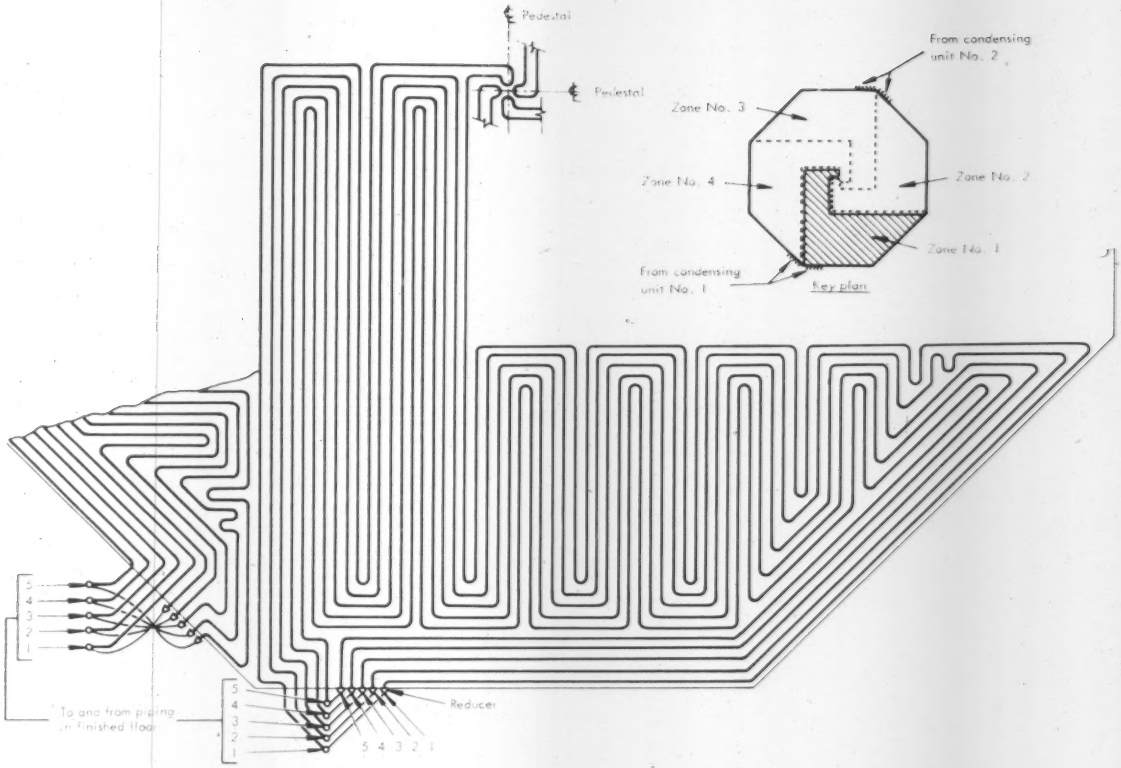
Phase 2 covered the dissipation of the heat of hydration of the 8 ft thick radar tower foundation beginning three days after placement. This phase of the operation involved the use of one 60 hp compressor installed on top of the 8 ft foundation connected to all four zones.

Each circuit was connected through individual risers to horizontal mains above the finished floor level and connected to the refrigeration equipment. A 3/8 in. pump-out line was taken from the bottom of each suction riser for pumping out liquid and oil in case of oil logging of coils.

Phase 2 extended from the end of Phase 1 until the time when all stored heat of hydration had been extracted from the foundation and the finished floor of the building poured in place, the foundation being within the limits of the building.

### Duplicate Use of Equipment

The same size equipment was used for Phases 1 and 2. This equipment included the 60 hp refrigerant




**4** REFRIGERANT PIPING SYSTEM for 8 ft thick octagonal foundation pedestal is divided into four zones, each serving ¼ of area. Each zone has five piping circuits of 1⅝ in. OD copper tubing, 250 ft in length. All piping is contained within 6 in. leveling slab immediately beneath pedestal. Tubing is placed on 6 in. centers, supported on T-bars 2 in. above grade

22 compressor units, separate air-cooled condensers with head pressure regulators, and 1500 lb capacity receivers. All equipment was mounted on a low bed trailer so that it could be moved from one building to the other.

Two oil separators in series were used in the hot gas line to limit oil circulation as much as possible. Separated oil is returned to the compressor crankcase.

This dual installation of separators was considered essential to prevent serious interference with the system operation due to oil logging of the evaporators.

### Phase Three is Complete Operation

Phase 3 concerns the operation of the system from the end of Phase 2 throughout the useful life of the facility. Essential equipment for Phase 3 consists of a pair of 2 hp air-cooled condensing units connected for permanent refrigeration, including all necessary automatic controls. There is one working and one spare circuit per zone connected to each compressor for use in this Phase.

Horizontal lines in the floor fill connect to the risers, which terminate in a box in the floor. One connected evaporator circuit is a spare. Three unused risers per zone are capped with a refrigerant holding charge so that they may be used in the future if the working evaporators develop leaks.

### Use Indicating Panel for Each Compressor

A 36-point thermocouple temperature-indicating panel is used at each compressor assembly for taking required readings every 15 minutes during Phase 1, and as required during Phases 2 and 3. Discharge, suction, and oil pressures are also recorded.

One zone has been set up for multipoint temperature readings for control, and other zones are operated to match conditions in this zone, namely: temperatures at the midpoint of the circuits below the 6 in. slab between each pair of circuits; at the interface above each circuit; at quarter points, bottom and top of the 6 in. slab; in the center, the bottom, and at 2, 4, and 6 ft levels above the interface; and on each liquid and suction line where it enters the slab.

Phase 1 was used for testing and adjusting the refrigerant system while back-freezing the crushed rock. The load was gaged by the liquid flow meters on the basis of 0.275 gpm per ton, the expected peak load from hydration of the 8 ft.-thick foundation being about 25 tons. This load was approximated during test by circulating hot air over the slab.

### System Capacity Is Variable

The capacity of the system can be varied as necessary by:

1) Unloading the compressors in steps of 1/8, 1/4, 1/4 and 1/8 capacity.
2) Throttling the suction service valve of the compressor.
3) Cycling the compressor.
4) Cutting off circuits.
5) Changing the superheat adjustment of the expansion valves.
6) Adjusting the head pressure control.

During Phases 1 and 2 every effort was made to keep conditions in each circuit and each zone uniform. Expansion valves were adjusted first to a 2 to 3 F superheat. Any unequal flow between zones was adjusted by throttling liquid or suction hand valves.

Evaporator temperature at peak load was about 20 to 25 F, and the compressor was adjusted to run continuously at this load with all cylinders operating, by throttling the compressor suction service valve to cut the capacity. The compressor is rated at 10 tons at 0.6 psi, −40 F suction and 80 F condensing temperatures.

### Operation Controlled Automatically

The system is controlled automatically for Phase 3 by a back-pressure switch set at approximately zero psi (−18 F). Permanently connected thermocouples at the center and in each zone are read periodically to check the temperatures of the frozen rock and frozen saturated fill material.

Other automatic controls include: expansion valves, set for minimum superheat; a high-low pressure switch set for safety control only; differential low-oil-pressure switch; and a thermostat with bulb at the bottom on the lee side of the tower foundation — an alarm is rung if the temperature rises to 28 F. Solenoid valves are installed to prevent flooding the system on shutdown.

### Test Procedures Comprehensive

Extremely rigorous testing procedures were stipulated because of the reliability and permanence required of the system. Piping was required to be gas tight for at least 10 years, while under 8 ft of concrete.

**TABLE 1 — SYSTEM DATA for refrigerant piping system during test phases 1, 2, and 3 is shown below**

| | |
|---|---|
| Phases 1 and 2: | |
| Refrigerant 22, per circuit | 110 lb |
| Refrigerant 22, per zone | 550 lb |
| Refrigerant 22, per compressor | 1250 lb |
| Receiver capacity, 3/4 full | 1000 lb |
| Phase 3: | |
| Refrigerant 22, per circuit | 150 lb |
| Refrigerant 22, per compressor | 400 lb |
| Receiver capacity, 3/4 full | 450 lb |
| Maximum hot gas temperature | 250 F |
| Maximum head pressure | 210 psig (105 F Condensing) |
| Minimum head pressure | 145 psig (80 F Condensing) |
| Compressor Minimum voltage | 400 v |

The system was run and tested under different conditions before starting placement of the 8 ft thick tower foundation. Air inside the form was heated to 90 F and the system tested under different running conditions to establish the best method of control. Refreezing of the crushed rock was accomplished during this period.

All circuits were connected to a common charging line. The charging line and individual circuits were isolated and purged with refrigerant. Once purged, all circuits were tested for leaks with 100 psi of nitrogen. Open valve ends, the charging line, and all circuits were tested. Each joint was tapped with a rubber hammer before testing with a leak detector.

All leaks found were repaired or remade, and the circuits retested. Tests were made again with 300 psi of nitrogen. All connecting piping, the air-cooled condenser, receiver connections, etc., were tested and connected in a similar manner.

As soon as the 6 in. slab was sufficiently hard to walk on, a leak detector, set at maximum sensitivity, was used to check for leaks at top surface of the concrete slab, directly above joints. Should a leak have been detected, it would have been necessary to dig up the joint, repair the leak, and patch the concrete. Table 1 shows the test conditions for the three phases.

Although hardly the type of assignment that the consulting mechanical engineer runs into every day, the general principles of refrigeration were applicable and ideally suited to the solution of this unique problem.

For the designers who were assigned this task, the demand for accuracy and successful operation was never more emphatic, and to date, the performance of both systems would seem to indicate that this refrigerant piping system, even though entombed beneath 2400 tons of concrete, can be relied upon to operate successfully. ⌖

HUGE AIR CURTAIN entrance for Pan American Airways terminal at New York's Idlewild airport was designed with aid of wind tunnel tests to determine size and position of outside wind screens. Screens were required to reduce and equalize wind pressure at entrance. Glass supply plenum for entrance measures 89 ft wide, 7 ft deep, and 23 ft high, requires 600,000 cfm air delivery

# Wind Tunnel Tests Help Design Air Curtain Entrance

By NORBERT ZEHNDER
Chief Engineer
Sulzer Brothers, Inc.

**• Air curtain entrances are being installed with increasing frequency in many parts of the country where the need for unrestricted access to commercial and other structures make the absence of doors a boon to the owners. Frequency of access is of course an important factor. Where doors are continuously used, an air curtain provides a permanent divider between outside weather extremes and conditioned inside air, and heating or cooling loads can be reduced. Such installations are becoming more nearly standardized, but in the case of a new airlines terminal building, the extreme width and height of the entrance posed special problems. Wind tunnel tests were used to determine the size and placement of wind screens to aid the air curtain in providing reliable and effective service.**

TODAY, one can enter a variety of commercial buildings in most kinds of weather without contending with a solid door of any sort. This is the contribution of the air curtain entrance — a "doorway" unseen but which, within the limitations of its design, offers unobstructed access from the street while fully insulating the building interior.

Ideally, the only sensation of an air curtain entrance is that of a gentle breeze, separating the air conditioned interior from the weather extremes of the outside.

## Balance "Chimney Effect" and Wind Pressure

The purpose of an air curtain entrance is to separate areas which have differences in pressure, temperature, and humidity, or to confine smoke or dust to one of two adjoining areas, without sacrificing accessibility.

During winter months, commercial air curtain installations are able to stabilize a difference in pres-

sure between the inside and outside air created by the "chimney effect" and by wind pressure.

Chimney effect occurs in every building whenever there is a difference in temperature between the interior and the weather outside. When a building is equipped with conventional doors, winter cold air enters at low levels and warm air escapes through various openings at greater heights.

Such an air exchange results in considerable heat loss in some instances. The tighter the building construction, the less will be the quantity of heat escaping.

To the negative difference in pressure caused by the chimney effect must be added the pressure of wind at the entrance. Therefore, the design basis of the air curtain entrance must be the total pressure differential resulting from these two factors.

In summer, an air conditioned building produces a "reverse chimney effect," by which cool air is lost and warmer air from the outside is admitted. An air curtain which restricts such an air exchange will reduce the cooling load for the building.

### Size Affects Design Considerations

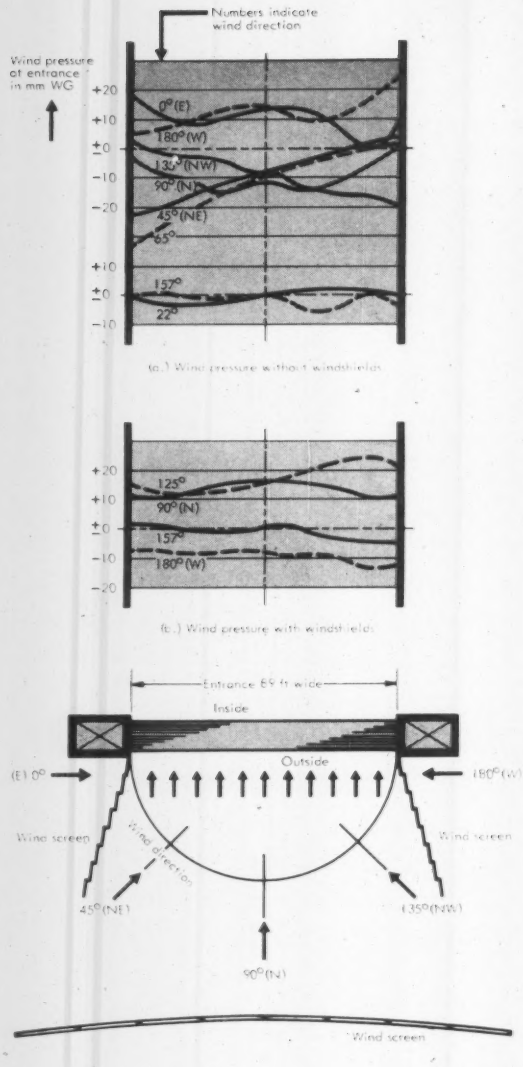
While it is a relatively simple matter to calculate and determine the design requirements for an entrance of small to medium size, a substantial increase in the area of the air blanket poses a number of interesting complications.

A case in point is the new Pan American Airways terminal building at Idlewild Airport in New York. The mainbody of this structure is covered by an elliptical canopy of steel and reinforced concrete with an area of approximately four acres. The canopy is supported independently by steel cables and peripheral concrete piers, and extends beyond the building lines to protect passengers boarding or leaving the line's aircraft.

In order to facilitate passenger traffic from the incoming roadways to the concourse level, an 89 ft wide air curtain entrance was designed and installed. Passengers arriving by motor vehicle are afforded a view of the entire span of the building, can see immediately where they should go, and even though the terminal will handle eight jet aircraft per hr no crowding or confusion need result from restricted entrance space.

### Use Wind Tunnel Tests for Design

Because of the unique design of the terminal, a complicated distribution of wind pressure had to be expected at the entrance. Therefore, in order to secure a reliable basis for the project, wind tunnel tests were approved. A complicated pressure distribution produced by winds upon buildings cannot be calculated, but must be determined experimentally using




**1** PRESSURE DISTRIBUTION curves for terminal entrance are plotted without windshields (a) and with windshields (b) above. Curves are plotted with easterly wind as base (000°)

scale models in controlled air movement.

Such tests are greatly facilitated by the fact that air flow around angular bodies is not affected by relative size. Thus, very small models can be used — for instance in a scale of 1:100 or 1:200 — in order to obtain accurate data regarding pressure distribution patterns.

### Conditions Indicate Limitations

A study of the wind statistics at Idlewild showed that because of an average wind velocity of 19 mph with maximum values of over 65 mph, the air curtain

would not be completely effective all the time.

Wind shields were therefore recommended; two at the sides near the entrance and a third large shield along the bridge to which the ascending ramps lead. These shields are intended to reduce the wind pressure at the air curtain, but just as important, to insure that such pressure is approximately equal over the whole width of the entrance.

Without shields, it can happen that an oblique wind will produce high pressure at one end of the entrance and low pressure at the other, so that the air curtain is pushed into the building at one point and pulled out at the other. The problem of control would then be greatly complicated.

### Tests Determine Screens Needed

The purpose of the model tests conducted in the wind tunnel of the Swiss Federal Institute of Technology in Zurich was to determine the necessary size and position of the shields.

Two series of tests were conducted; the first with a model in 1:200 scale to examine the broad outlines of the problem, and the second with a 1:100 model with which accurate final measurements were obtained. Owing to the size of the building, this second model was of very respectable dimensions, the long axis of the oval roof measuring 5 ft.

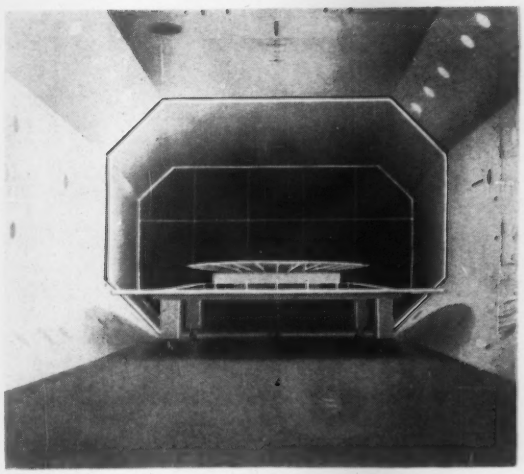
With the first model, 15 different arrangements were tried and 89 pressure distribution curves measured, each comprising 10 measuring points, while with the second model 99 pressure distributions with 14 points each were plotted for 20 arrangements.

In evaluating the measurements, the maximum wind speed at which the air curtain would still function reliably was calculated for each arrangement, so that with the aid of wind statistics for Idlewild it was an easy matter to estimate the frequency and duration of periods during which the air curtain is in danger of giving way.

The wind tunnel itself measures 10 ft wide and 7 ft high. The maximum available wind speed is 200 mph. Models could be rotated within the enclosure, and hose connections led from measuring holes to a multiple manometer outside the tunnel. Pressure distribution could be seen at a glance, and the measurements were recorded while the model was turned slowly. Readings were taken at fixed angles which showed a characteristic pressure distribution of practical importance. Fig. 1 shows pressure distribution curves along the entrance for various angles of wind incidence, with and without shields.

### Tests Lead to Recommendations

After evaluation of these tests, recommendations were made as to heights of the wind screens, openings in the roof to permit release of excessive air pressure, and sizing and disposition of the equipment.



SCALE MODEL of terminal building was used in wind tunnel tests to determine proper size and location of wind screens, used to reduce and equalize wind pressure at entrance

Based on the finally accepted disposition, the efficiency of the air curtain was calculated at approximately 95 percent. That is, during 95 percent of the time the curtain will work effectively, and during the remaining 5 percent of the time emergency doors may have to be used. Such performance called for an air volume of 600,000 cfm.

In conjunction with the wind tunnel tests, the most difficult problem to be solved then became the disposition of the necessary equipment.

### Use High Velocity, Large Volume

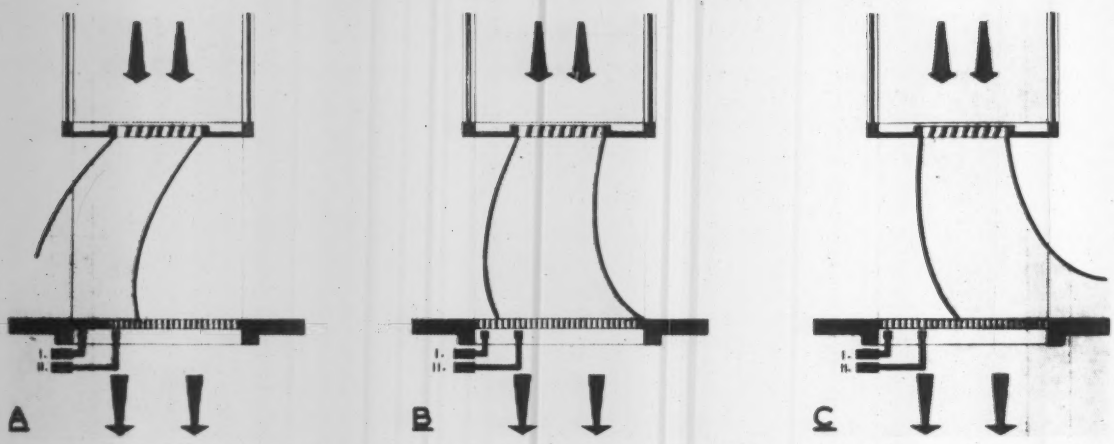
Heating coils and air filters are located in a 130 ft long aluminum housing on the roof. Six axial fans, each driven by a 75 hp motor and with a total capacity of 600,000 cfm deliver air from this housing, through silencer units, and into a huge glass supply plenum 89 ft wide, 7 ft deep, and 23 ft high. The air curtain passes through the delivery grille and blankets the entire entrance. An aluminum grating with free openings of 7/32 in. between bars is installed at floor level.

A stainless steel pan beneath the floor grating is equipped with an automatically operated flushing device to collect dust and dirt from the returning air.

### Return Air Circuit Most Difficult

The remaining circuit, for transporting air from the floor grating back to the equipment room on the roof, represented the most difficult problem from the designer's point of view.

Air velocities in the return ducts are as high as 5000 fpm at certain points. This is due to the fact




**2** THREE CONDITIONS of control are illustrated above. Center figure (B) shows ideal state when air curtain enters return grille just inside frame. When air curtain blows out (A) control element I senses temperature increase and reduces discharge angle. Control element II senses temperature decrease when air curtain blows in, increases discharge angle and fan speed

that the space available for return ducts in the level beneath the concourse was restricted. The whole building had to be designed within two given limits: the high water table at Idlewild, and the sight lines from the control tower. Operators in the tower must be able to see every plane at any time, and building heights are thus severely restricted.

An acceptable disposition for the return ducts in the apron level ceiling was finally found after structural steel members had been rearranged, electrical conduits revamped, lighting redesigned, and air conditioning ducts and heating piping changed.

Above the floor of the concourse level, two vertical glass ducts bring the return air back to the equipment room on the roof.

### Devise Automatic Control System

In order to secure an effective and economical operation of the air curtain, an automatic control system was developed.

The efficiency of an air curtain varies with changes in the quantity of air, outlet velocity at the supply grille, and discharge angle. Therefore, the quantity of air supplied and the angle at which it is discharged are the two variables to be controlled automatically.

The ideal air flow for an air curtain entrance is shown in Fig. 2b. Here the boundary layer of the air blanket, consisting of a mixture of curtain air and outside air, enters the return grille at floor level just inside the floor grille frame.

When the circulating air is heated, usually when outside temperature is below 65 F, various sensitive thermistor elements register a difference in temperature as soon as the air screen deviates from its proper position, thus securing very accurate flow control.

If the air curtain is blowing out to the side walk, as shown in Fig. 2a, the control element I senses an increase in temperature and causes a reduction of the discharge angle and if necessary of the fan speed. Temperatures increases of 1 F are registered within 1 second.

If operating conditions change in such a way that the pressure difference between inside and outside of the entrance increases, the air curtain is "bent" into the building. (Fig. 2c) Control element II then registers a decrease in temperature and causes the discharge grille vanes to move towards the outside, thus increasing the air discharge angle and eventually the fan speed.

Such a system provides very precise and economical control, but can operate only when the air curtain air is heated, or during the winter months and part of the spring and fall.

### Use Second Control System for Summer

Therefore, a second control system is used for summer operation, wherein air quantities and discharge angle are controlled by instruments sensing wind velocity and wind direction. Switching from winter to summer operation and back again is done automatically in accordance with variations in the outside temperature.

This new and unique type of entrance is becoming increasingly popular throughout the country. In order to design and install effective entrances of the air curtain type it is imperative that architects, consulting engineers, plant and building engineers, and mechanical contractors work closely together so that the entrance will look and operate at its maximum potential. ‡

# How to Use Heat Transfer Petroleum Fluids For Snow Melting Systems

**• Snow melting systems are widely useful in commercial and industrial areas where foot or vehicle traffic must be provided with sure traction. Piping grids of various materials supplied with heat transfer fluids frequently do the job. In some cases petroleum fluids may be used for this purpose but careful planning is needed to insure maximum performance. This article explains some of the considerations necessary to successful use of aromatic petroleum heat transfer fluids in alleviating one of business's most troublesome chores.**

By R. B. PURDY
Socony Mobil Oil Co., Inc.

MANY SECTIONS in the United States suffer in winter from heavy snowfall, and those responsible for its removal from areas such as loading platforms, airports, public or business building sidewalks, hospital driveways, and industrial plant areas often find this an expensive and time consuming chore.

But where snow melting systems are installed, this problem and chore can be alleviated. When properly engineered and operated, such systems melt the snow as it falls. Accumulations do not occur, and sidewalks, platforms, and similar areas are usable during and after severe storms. These systems have been used successfully for many years. One that may be still the largest was installed in 1950 using steel pipe, at the Port of New York Authority Bus Terminal.

### Systems Are of Two Types

Systems used for this purpose can be classified under two types: 1) those using electric heating coils embedded in the area to be kept free from snow, and 2) those using heated fluid circulated through pipes in the pavement.

This article discusses the use of petroleum fluid for this purpose, and those features of such a system which are desirable to assure the best performance from the fluid and from the system.

### Should Hinder Corrosion

It is important that the fluid used in these systems protect the piping against possible internal corrosion or plugging by deposits. Obviously, digging up pavement to replace a corroded or plugged coil is an expensive operation.

The use of a correct petroleum fluid provides good assurance for internally clean, uncorroded pipe. This is demonstrated by the installation in the ramps of the bus terminal mentioned earlier, which is still operating with the original charge of aromatic petroleum fluid after 10 yrs of service.

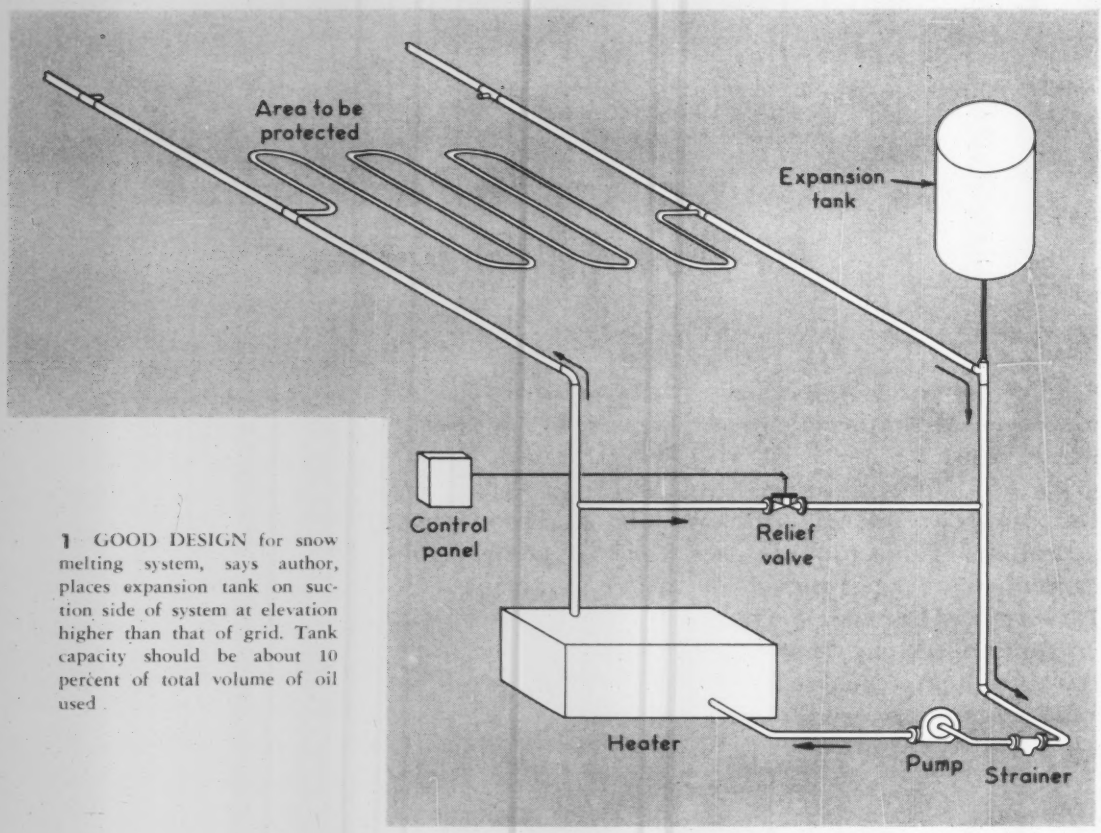
This installation also demonstrates the stability of aromatic-type fluid; its resistance to deterioration in service and its ability to keep the system clean and free from deposits.

In industrial service, aromatic oil of this type, but of higher viscosity, has been in service at temperatures of from 300 to 600 F for as long as 20 yrs without sufficient change to justify its replacement. At much lower temperatures permitted in snow melting service, such fluids should operate indefinitely.

### Viscosity May Vary

During cold but snow-free periods when the system is idle, the fluid in the grid gets cold, and the viscosity of the oil in service increases. The use of an incorrect oil may mean that at low temperature the viscosity will be high enough to require excessive pump pressure to circulate the fluid during start-up.

A low viscosity fluid should be used, so that start-up at low temperatures will be easier. Where centrifugal circulating pumps are used, excessive viscosity can be critical, because the shut-off head of the pump may be reached. In such an instance, the system could not be started at all.




**1** GOOD DESIGN for snow melting system, says author, places expansion tank on suction side of system at elevation higher than that of grid. Tank capacity should be about 10 percent of total volume of oil used

Aromatic petroleum fluids are not toxic. They are in a class of combustible but "non-flammable" liquids, which will not burn unless exposed to a source of ignition. Flash points for such fluids are well above the temperatures used for snow melting.

### Need Faster Circulation

The specific heat of petroleum fluids is less than that of water-antifreeze mixtures, and it is necessary to circulate oil at higher rates to accomplish the same output of heat. The extra cost of larger pumping capacity will be offset if better corrosion protection is attained.

### Design For Oil Used

For the best performance of the system and the petroleum fluid, the system should be designed especially for the oil that will be used. This involves correct pipe sizing as well as other features.

When used in such systems, copper and copper alloys may act as catalysts and promote oxidation and sludging of the petroleum fluid. The use of inhibited oils, however, prevents this from happening. Small copper parts such as controls, valves, and instruments, can be used freely. Packing and gaskets should be of a material that is resistant to hot petroleum. Iron or steel piping can be used with these fluids.

### Most Systems Use Steam

In most snow melting installations, steam is used to heat the transfer fluid. Heat exchangers or converters are generally of shell-and-tube construction, arranged so that the heat transfer oil circulates through the tubes and the steam surrounds them.

Steam pressure of 25 psi is generally sufficient to heat the oil to the required temperature. The temperature of the oil entering the snow melting coils should never be above 160 to 175 F, as higher temperatures may cause deterioration of the concrete in which the coils are usually embedded.

Heaters of this type are usually provided with thermostatic controls which maintain the temperature of the oil leaving the heater at the desired value.

Electric heaters can also be used for this service. If used, it is important that the electric energy be supplied at a "safe" rate, in w per sq in. of heater surface; otherwise oil film temperatures can be developed that may be injurious to the heat transfer fluid. This safe

rate depends on the velocity of the oil circulating over the heating surfaces and on the design of the heater.

### Expansion Tank Needed

Petroleum heat transfer oil expands when heated. The amount of expansion of aromatic oil can be calculated from the equation which states that the percentage increase in volume equals 0.035 times the increase in temperature.

In snow melting systems, the increase in volume can be assumed to be 5 percent of the total volume of fluid in the system.

A correctly designed expansion tank permits the oil to expand without being exposed to the oxidizing influence of air. In sense, such a tank functions as an oil seal to insure that only cold oil comes in contact with the air.

The maintenance of low oil temperature in the expansion tank contributes materially to long service life for the oil. In general, the temperature of the oil should not rise above about 130 F.

Sizing of the tank should be such that, when the oil is cold, the tank will be about ¼ full, and ¾ full when the oil is hot. Therefore, the tank capacity should be twice the calculated expansion volume, or in the case of snow melting systems, 10 percent of the total volume of oil used.

### Elevate Tank

The expansion tank should be located at an elevation higher than that of the snow melting grid if possible. This may, however, prove unfeasible in some applications.

A higher tank will keep all portions of the system under pressure at all times, and help to keep the system free of air. A tank installed in this manner should be vented to permit air to escape. When the expansion unit is installed below the level of the grid, a pressure tank is required.

Expansion tanks should be connected to the suction side of the system. (Fig 1) The connecting pipe should be moderate in size, and need not be over 2 in. in diameter even for relatively large installations. Larger diameter pipe encourages convection currents that can heat the oil in the tank. Neither the tank nor the connecting pipe should be insulated.

### Pumps Are Varied

Either centrifugal or positive displacement pumps are used for oil circulation. When centrifugal units are used, they must be capable of providing the increased pressure needed for starting the system when cold. Often a spare pump is provided.

In some installations, both the service and spare units operate during start-up, after which one can be secured after the system is warm. Packing used in pump glands must be of a type that will resist deterioration by hot oil.

### Control Choice Possible

Pressure gages and thermometers should be installed at various points in the system. Installations may be manually controlled, with full-on or full-off alternatives, or automatic controls may be provided to maintain the desired temperature.

Some installations also provide means for controlling the temperature difference between the fluid supplied to the snow melting coils and the return from them. Such a control operates a three-way valve to mix quantities of heated and unheated fluid, thereby maintaining a temperature differential.

The viscosity limit of the heat transfer fluid can be controlled by using a low limit thermostat. As a safety measure, low and high level alarms are often provided on the expansion tank.

### Describe Typical System

The new Mutual Life Insurance Co. building in Newark, N.J., is a relatively recent, typical installation using aromatic petroleum heat transfer fluid. The system cleans snow from sidewalks and loading driveways.

Snow melting grids are of 1 in. wrought iron schedule 40 pipe, on 12 in. centers. A 6 in. concrete slab is separated from the gravel base by a polyethylene membrane to prevent water seepage through the concrete.

Grids are placed 2-½ in. below the surface of sidewalks and 3 in. below the surface in driveways.

A total volume of 700 gal is used for the system, with a 100 gal expansion tank placed below the grid but 25 ft above the circulating pumps. Due to the level, the tank is under pressure and is therefore provided with a valve to permit control of air pressure above the oil level.

Two centrifugal pumps are used, each of which has a 455 gpm capacity. One of these is retained as a spare. A 2 million Btu per hr steam converter operates at 10 psi.

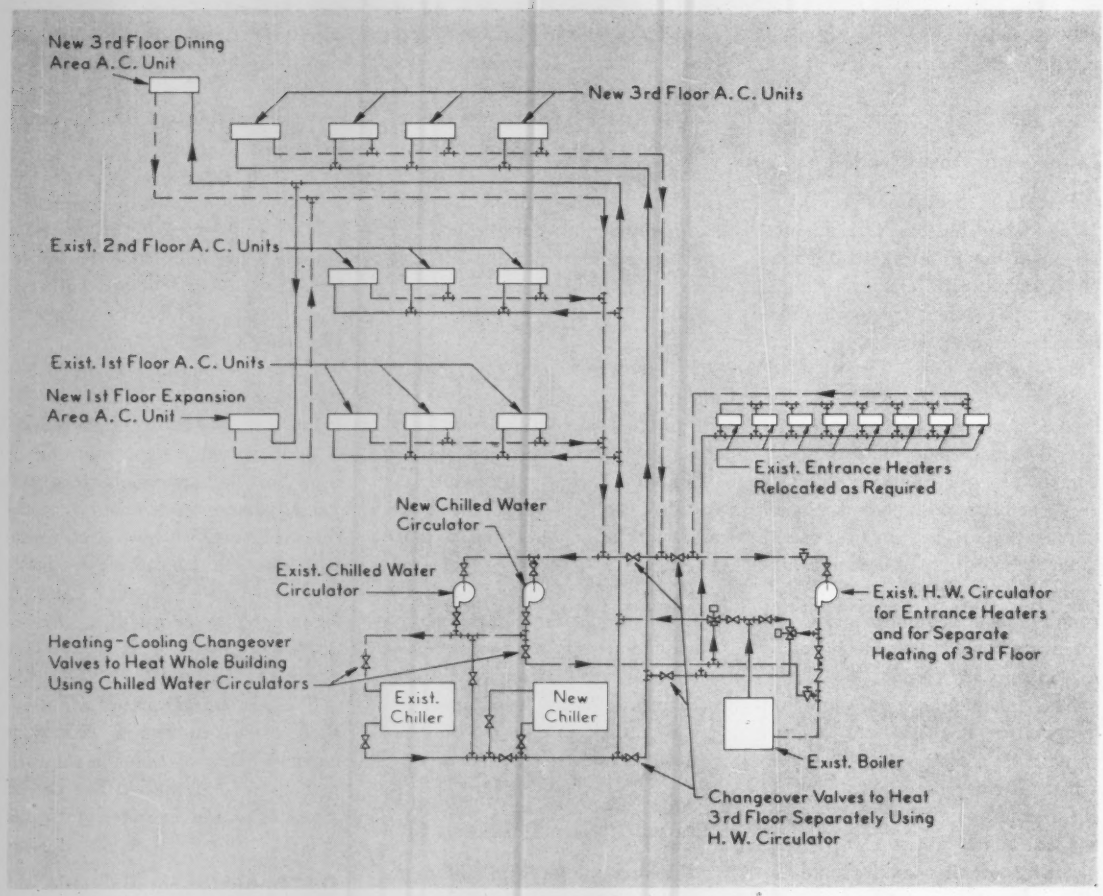
### Oil Temperature Variable

Except for unusually heavy snow storms, the system is operated with an oil temperature of 140 F at the heater. In most severe weather, control can be changed manually to produce an increase in oil temperature to 170 F.

After installation, the system was tested with air at 300 psi and all joints were checked with a soap solution. Testing with water is inadvisable because it is almost impossible to remove all water from the system. During operation, the presence of excessive water can cause troublesome oil foaming.

Testing can be accomplished by using the aromatic heat transfer fluid that will ultimately fill the system.

Syska and Hennessey, consulting engineers, designed the Mutual Benefit Insurance Co. system, which was installed by Mance Corp. ±


New 3rd Floor Dining Area A. C. Unit
New 3rd Floor A. C. Units
Exist. 2nd Floor A. C. Units
Exist. 1st Floor A. C. Units
New 1st Floor Expansion Area A. C. Unit
Exist. Entrance Heaters Relocated as Required
New Chilled Water Circulator
Exist. Chilled Water Circulator
Exist. H. W. Circulator for Entrance Heaters and for Separate Heating of 3rd Floor
Heating-Cooling Changeover Valves to Heat Whole Building Using Chilled Water Circulators
Exist. Chiller
New Chiller
Exist. Boiler
Changeover Valves to Heat 3rd Floor Separately Using H. W. Circulator

CHILLED WATER and hot water heating flow diagram illustrates how early planning permitted rapid and economical expansion of systems when department store built 100 percent addition

# Early Planning = Easy Expansion

## . . . to meet the air conditioning needs of a growing business

by R. R. KIRKWOOD
John Graham and Co.
Architects & Engineers

SOMETIMES owners, architects, mechanical designers, and equipment contractors associated in the construction of a sizeable business structure are faced with the happy likelihood of the need for future expansion due to burgeoning business operations.

In such a circumstance, economy requires that the planning for the original building be such that any future additions can be added at minimum cost and with minimum interference with the going business.

This is particularly true in regard to the mechanical heating-cooling systems, since today the more efficient and certainly more useful air conditioning services represent such a large percentage of overall investment.

In some situations, where it is known beforehead that the air conditioning system will be op-

**• The best year 'round air conditioning design can be an economic failure if it does not provide for future expansion needs which can be reasonably anticipated. Conversely, an original design and installation is considerably enhanced if it combines adequate operation under present conditions with provision for easy expansion at some future date. Such a plan was developed for the Diamond Department Store in Phoenix. The mechanical engineer associated with the design for the system tells what means were employed to insure that a growing business would be provided with a year 'round air conditioning system to match its needs along the way.**

erating at close to design load conditions, the possibility of easy and complete integration of the initial system with future expansion equipment must surely be worked into the original scheme.

### Store Expects Growth

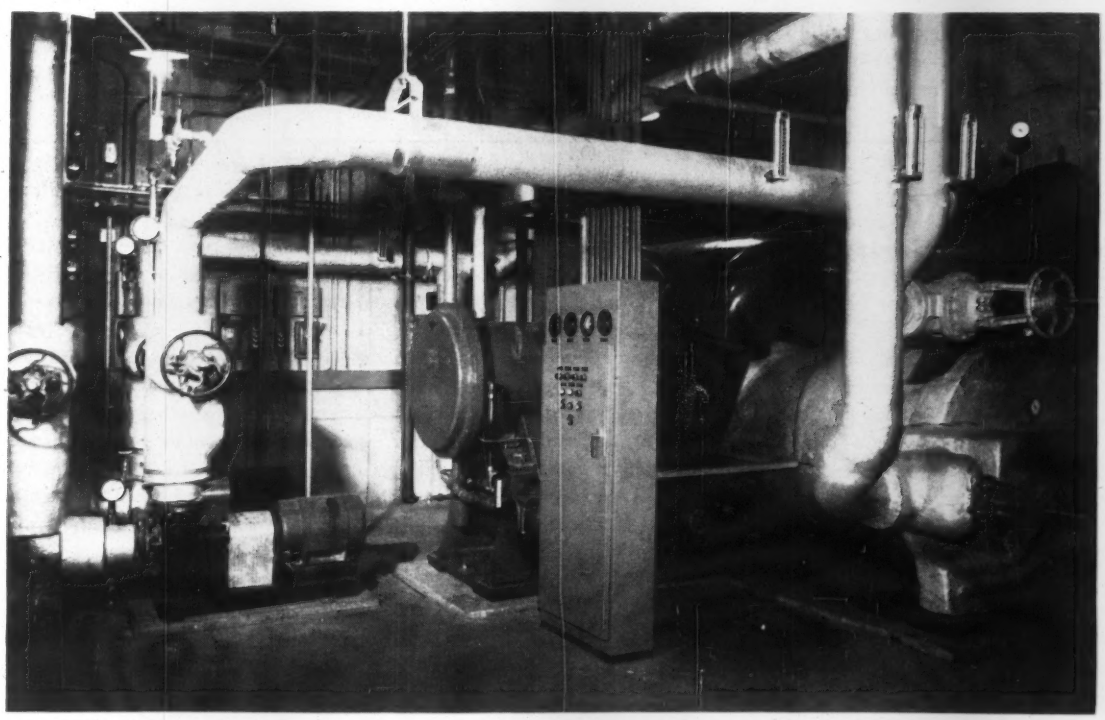
Such a development occurred in the case of Diamond's Department Store in the Phoenix, Arizona, Park Central shopping center. Here, the original structure was opened in 1956, but within three yrs business had increased to such an extent that it was necessary to plan a 100 percent addition to the building.

Fortunately, the expansion program had been anticipated during the design stages of the original building, so that integration and expansion of the year 'round system could proceed with a minimum of expense and interruption to the business.

The original installation provided summer air conditioning by means of a single 240 ton capacity centrifugal chiller, which furnished chilled water for cooling to the coils of individual air handling units located throughout the building on a zone basis.

### Provide More Chiller Space

At the time of installation, space was provided for the addition of a second chiller, comparable in size and type to the first. Now the expansion program is complete, and the first centrifugal chiller has been modified to operate on a 2-pass principle, whereas once it used a 3-pass method. This will be accomplished by changing the



ORIGINAL 240 ton capacity centrifugal chiller, which operated on 3-pass principle, has now been modified for 2-pass operation, is joined by second chiller of comparable size to serve expanded cooling needs

baffles in the water boxes to permit series connection of the new and existing chillers.

Heating for the building is provided from a gas fired hot water boiler, which distributes hot water to the same coils used for cooling in the individual units. This boiler was sized to accommodate the expected increase in requirements at the time of installation. Thus, only piping to the additional air handling units is necessary.

Individual units in the air distribution system are suspended in a dropped section of ceiling on each floor. The addition to the structure includes another level above the original two-story building. For this reason, it will be unnecessary to install more air handling units on the second floor, because even though the area at this level will be increased, the additional cooling demands approximately equal the decrease in load brought about by the elimination of the original roof load.

### One Coil Heats, Cools

Both in the existing building and in the addition, chilled water is circulated to the individual coils through a 3-way valve arrangement. When heating is required in any zone, the valve is reversed and hot water enters the coil. Manual changeover from heating to cooling function is provided at each unit.

### Top Floor Special Case

On cold mornings, especially after a weekend shutdown, heat may be required on the top floor (which has an exposed roof) while cooling is needed on the lower levels. Additional manual valves are included in the system to allow hot water to be circulated through the upper coils while the rest of the units are furnished with chilled water.

Main floor entrances are equipped with vertical unit heaters concealed in the ceiling to handle the additional load imposed by frequent opening and closing of doors.

### System Entirely Expandable

The original planning included all the major units in the expansion provisions. For instance, the existing cooling tower will be removed from the present roof level and reinstalled on the new roof. The single tower will then be supplemented by a second unit of approximately the same size. Both will use a common basin to permit operation as a single tower with one water treatment system.

Again, the centrifugal chiller piping is planned so that when both units are placed in operation, either may be by-passed for possible repairs or necessary maintenance. This is a most desirable feature in Phoenix, where design temperature is one of the highest in the country, and where, consequently, air conditioning is a year 'round proposition.

Careful attention to future needs of the customer has resulted in a design and installation which can handle an expansion program with a minimum of interference, expense, and inconvenience.

The system was designed by John Graham & Co., and the original components were installed by the Frank Harmonson Co. Valley Sheet Metal Co. is the mechanical contractor for the additional equipment. ±

*Photo on page 127 courtesy American Standard Industrial Div.*

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## *Year 'round air conditioning could mean year 'round schools*

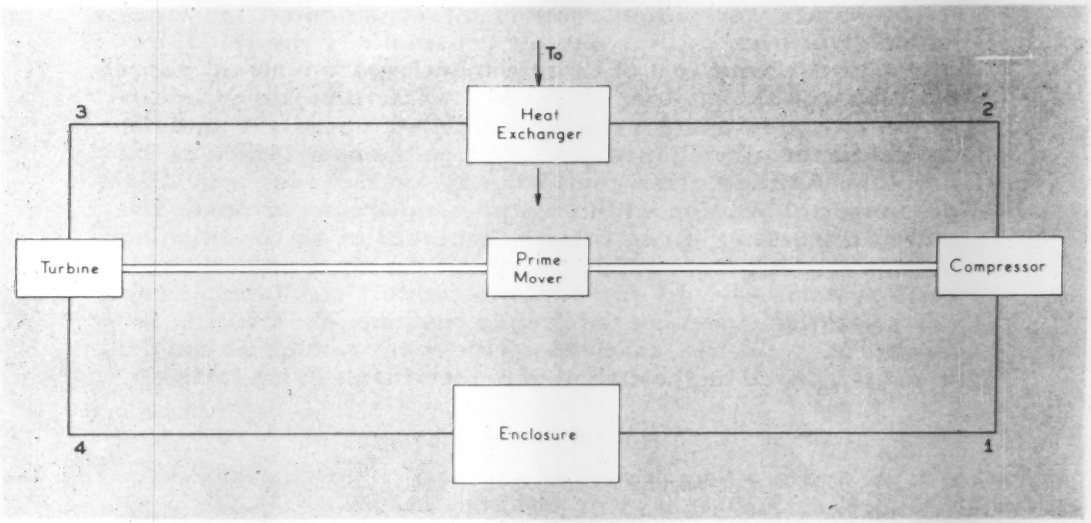
ONLY a ten percent increase in school building costs invested in air conditioning would provide communities with school buildings with a 25 percent increase in usefulness, according to Don Petrone, president of Typhoon Air Conditioning Div., Hupp Corp.

An even greater opportunity for stretching the community's educational dollar would be "the elimination of the need for many new schools if existing educational plants could be used to full capacity the whole year," he said.

"Schools now cost communities $20 per sq ft, and can be used only for nine months of the year because of hot weather. An additional $2 a sq ft would allow the installation of air conditioning, effecting a 25 percent gain with a 10 percent outlay."

Two important benefits gained by the addition of the summer months to the school year would be the lessening of double and triple shifts and the full utilization of our teachers. Now teachers are forced to seek other employment during the summer to compensate for the time they are not teaching.

Summer vacations for our children have become a habit in urban communities only because there was nothing else to do, Mr. Petrone explained. "But faced as we are with obvious ceilings on real estate taxes, this appears not only the most logical solution to the problem, but one of the most economical." ±




**1** AIR CYCLE SYSTEM for commercial aircraft, diagrammed above, is relatively light weight, can be adapted to provide cabin pressurization without major equipment additions

***Engineers meet new problems in***

# Air Conditioning and Pressurization For Modern Commercial Aircraft

By VICTOR CHUN
Mechanical Engineer

THE PRINCIPLES involved in air conditioning for comfort in buildings and in aircraft are essentially the same. However, since aircraft are not stationary objects, they pose some additional problems for the designer. These include:

1) A pressure variation at different altitudes
2) A wider range in design temperature
3) Increased criticality of equipment weight.

Modern commercial planes are equipped with both comfort air conditioning and pressurization systems; the former for the convenience of the passengers and the latter because it is required to sustain life at high altitudes.

## Two A.C. Methods Used

The two most commonly used air conditioning methods for aircraft are 1) the Air Cycle system, and 2) the Vapor Cycle system. Advantages accruing to the use of the air cycle method are light weight of equipment and its adaptability to use for cabin pressurization without the need for major equipment additions.

The vapor cycle is the more efficient of the two from a thermodynamic standpoint, and thus requires less power to operate. It is also capable of providing dehumidification.

We shall discuss the factors to be considered for each system in its turn.

## The Air Cycle System

In the air cycle system, atmospheric air is subjected to compression and expansion, which results in an increase in pressure and a drop in temperature. In Fig. 1, air discharged from the enclosure (or outside air with an open system) enters the compressor at temperature $T_1$ and at pressure $P_1$. As the air is

**• The task of providing comfort air conditioning for land-bound structures and for aircraft is essentially the same, except that the very fact of three-dimensional movement poses additional problems with airplanes. Pressure variation at different altitudes, a wider range in design temperature, and the critical factor of weight serve to change the complexion of the problem. Altitude gives rise to the added need for providing pressure stabilization within the passenger compartment. The author discusses the two common methods of air conditioning used in modern commercial aircraft — the air cycle and vapor cycle systems — and explains the comfort conditioning and pressurization systems used for the familiar DC-7C and in the newer DC-8 jet. He concludes with some comments on the questions posed by the arrival of higher, faster flying jet liners.**

being compressed, the increase in temperature (absolute) is

$$T_2 - T_1 = T_1 y_c (1/\eta_c)$$

*where*

$y_c = r^{.283} - 1$
$r = P_2/P_1$
$\eta_c$ = adiabatic efficiency of compressor

The air discharged from the compressor then enters the heat exchanger at temperature $T_2$ and pressure $P_2$, and leaves the exchanger at temperature and pressure $T_3$ and $P_3$. The inlet temperature of the coolant of the heat exchanger is $T_0$. The effectiveness ($E$) of the heat exchanger is expressed as

$$E = (T_2 - T_3)/(T_2 - T_0)$$

In this analysis we shall neglect pressure loss through the heat exchanger. The air enters the turbine at temperature and pressure $T_3$ and $P_3$, and is discharged at the characteristics $T_4$ and $P_4$. Thus, temperature drop is

$$T_3 - T_4 = T_3(y_t/(y_t + 1)\eta_t$$

*where*

$y_t = r_t^{.283} - 1$
$r_t = P_3/P_4$
$\eta_t$ = adiabatic efficiency of turbine

The power input to the cycle through the prime mover is the difference between the compressor power input and the turbine power output. The turbine power output (per lb per minute of air flow) is:

$$H_t = C_p(T_3 - T_4)\eta_t$$

*where*

$\eta_t$ = mechanical efficiency of turbine
$C_p$ = specific heat

The power input to the compressor is:

$$H_c = C_p(T_2 - T_1)/\eta_2$$

*where*

$\eta_2$ = mechanical efficiency of the compressor

The heat removed from the enclosure (per lb of air flow) is

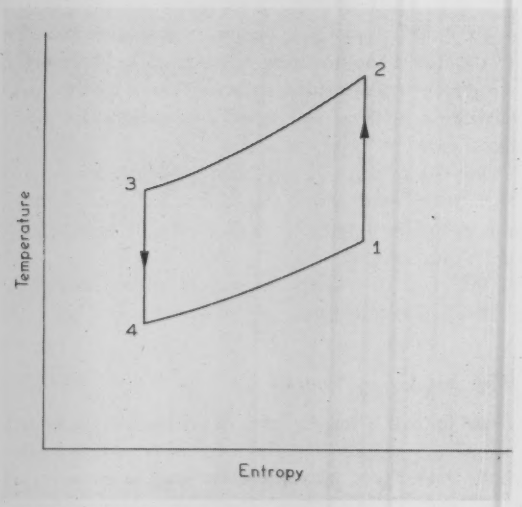
$$Q = C_p(T_1 - T_4)$$

The cooling capacity of the air cycle expressed in Btu per minute can be obtained by multiplying $Q$ in Btu per lb by air weight flow in lb per minute. One ton capacity is equal to 200 Btu per minute. The coefficient of performance ($COP$) is equivalent to the cooling capacity divided by the power requirement expressed in the same units, or

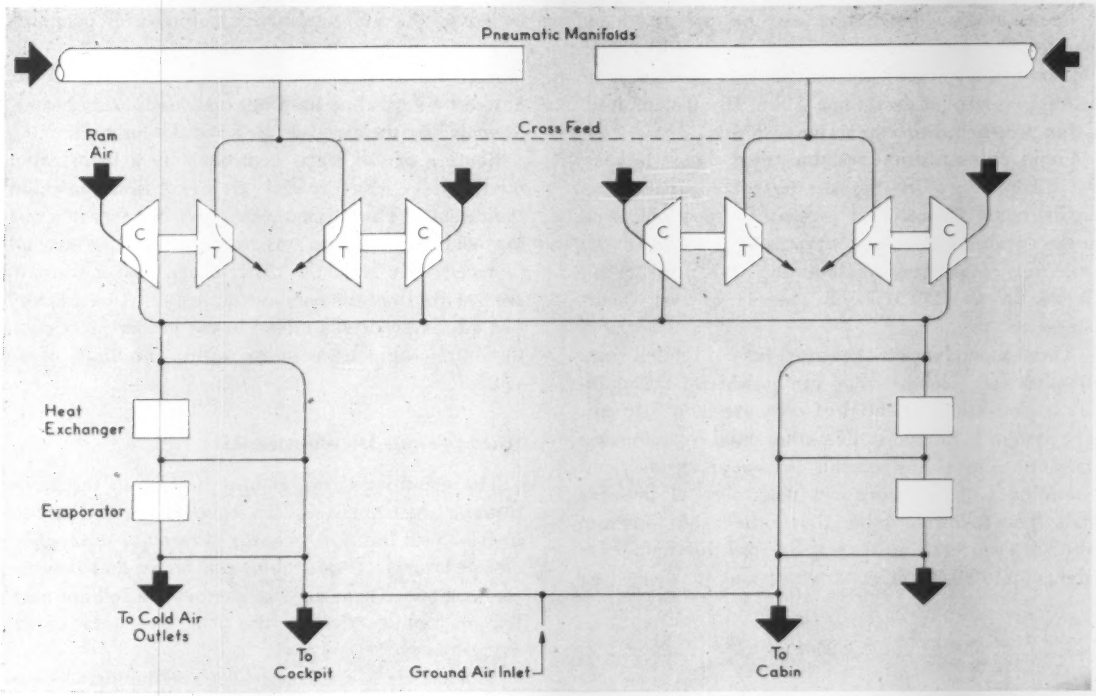
$$COP = Q/H_c$$

Fig. 2 shows the air cycle path on a temperature-entropy diagram. Points noted correspond to the same points numbered on the basic system schematic in Fig. 1. Curve 1-2 is the isentropic compression; 2-3 the isobaric cooling in the heat exchanger; 3-4 the isentropic expansion in the turbine; and 4-1 the isobaric heating of air in the enclosure.

This air cycle system is used to air condition the




**2** AIR CYCLE PATH with points corresponding to those on Fig. 1. Air cycle system is used in familiar DC-7C aircraft




**3** VAPOR CYCLE air conditioning flow diagram, for system as used in DC-8 aircraft, is shown above

DC-7C aircraft familiar to many, because of its light weight. The air cycle system used here, with a 5 ton capacity, can maintain the passenger compartment at a temperature 15 F below the ambient air temperature without cabin pressurization, and delivers conditioned outside air to the cabin at the rate of 112 lb per minute at sea level conditions.

### The Vapor Cycle System

The vapor cycle method of cooling, using refrigerant 12, is commonly known in commercial air conditioning; therefore detailed explanation is unnecessary. The application of this principle to the new DC-8 jetliner is, however, explained in the following.

High energy air at 450 F and 38 psi is taken from the four jet engines to drive four turbo-compressors which pressurize the cabin and supply outside air to two independent vapor cycle air conditioning units.

Due to the availability of high energy air, light and compact units are used to drive the refrigerant compressor and fan. For example, the centrifugal compressor, with a capacity of 13.7 tons, weighs about 10 lb. A commercial compressor with the same capacity as that 10 lb unit weighs about 700 lb without the motor.

In addition to the vapor cycle air conditioning unit, an air to air heat exchanger is used to provide cooling during flight. Under normal cruising conditions, this heat exchanger provides all the cooling required, with the vapor cycle system being used for low altitude flight and for cooling on the ground.

### Pressurization A Vital Factor

The two most important factors influencing the safety of passengers at high altitude are 1) atmospheric pressure variation, and 2) the rate of pressure change.

As altitude increases, atmospheric pressure drops. Too great a decrease can endanger human life. At an altitude of 63,000 ft, the barometric pressure of 1.847 in. Hg is equal to the vapor pressure of water in the human body.

At such altitude, the blood and other body fluids will boil at 98 F. At 50,000 ft, the barometric pressure of 3.436 in. Hg is equivalent to the partial pressure of water vapor and carbon dioxide in the lungs. Under such conditions, no oxygen can be inhaled.

Even at an altitude as low as 16,000 ft, anoxia (lack of oxygen) fatalities may occur.

### Rate of Change Dangerous

When a plane is making a fast ascent the pressure decreases rapidly. The rapid pressure change which occurs between ground and 30,000 ft can cause formation of nitrogen bubbles in the blood; a condition known as aeroembolism (the bends), which causes acute pains in and about the joints.

These adverse conditions can be prevented by maintaining cabin pressure equal to an altitude of not more than 10,000 ft. and the rate of change of cabin pressure at less than 1 in. Hg per minute. Cabin pressurization can accomplish this.

Cabin pressurization systems are designed to keep the air pressure in the passenger compartment as nearly equal to sea level pressure as possible, even at the varying altitudes of a typical flight. The DC-7C system is capable of maintaining this pressure on flights up to 12,270 ft. by means of two superchargers.

These superchargers, however, have a limited compression ratio, so that they are capable of maintaining a pressure differential of no more than 5.46 psi. The system is limited to this differential by automatic pressure control instruments, to avoid an overload condition with a consequent possibility of impeller stall. The following table shows the cabin pressure altitude *vs* aircraft altitude at 5.46 psi differential for flights up to 30,000 ft.

| Aircraft Alt. | Cabin Alt. |
|---|---|
| 12,270 ft | Sea level |
| 15,000 ft | 1820 ft |
| 20,000 ft | 5040 ft |
| 25,000 ft | 8000 ft |
| 30,000 ft | 10,760 ft |

### Vital Areas Pressurized

All vital interior compartments in the DC-7C are pressurized, excluding only the interior of the wings and the extreme tail sections. Since the superchargers discharge air to the cabin in a definite quantity (59 lb per minute per supercharger) the cabin pressure can be controlled by regulating the air to be exhausted from the cabin through a control valve located in the air conditioning accessories compartment.

The control valve is positioned by an actuator which receives its signal from the cabin pressure control instruments. Under normal conditions the air in the passenger compartment is changed approximately once every 2½ minutes.

For safety, cabin pressure can be controlled by cable operation of two emergency valves on the after pressure bulkhead and one butterfly valve in the fuselage. In addition, a negative pressure relief valve on the after bulkhead operates to admit air in case the interior pressure drops below that of outside air.

Air for both air conditioning and pressurization of the DC-7C cabin is admitted through scoops in the leading edge of each wing to a plenum chamber in which moisture or ice particles are removed, thence to the supercharger. In case the supercharger is inoperative, a bypass duct and check valve will admit air to the system. Ducts in the wings lead to a tee connection in the fuselage, from which a single duct is led to the air conditioning accessories compartment.

Here air is either sent through the after cooler, heated by a gasoline fired internal combustion heater, or cooled by the air cycle air conditioning unit.

Routing of the air is controlled by a main cabin mixing valve which receives its signal from the cabin thermostats. The mixing valve has three ports; one for cold air from an expansion turbine, a second to receive air from the after cooler, and a third to receive air from the combustion heater. Air from any two adjacent ports is mixed in the proper proportion to control cabin temperature within the limits of 45 to 85 F.

### Duct System Distributes Air

The conditioned air is introduced into the cabin through ducts built in the cabin floor and in the interior wall lining. Discharge is through rectangular outlets located on the cabin wall above and between the windows. These ducts also provide a radiant heating or cooling effect to the floor and walls of the compartment.

Exhaust air is removed through wall outlets located beside the passenger seats to be exhausted overboard. For individual comfort, adjustable cold air outlets are provided adjacent to each seat.

### Cockpit Served Separately

A separate mixing valve provides conditioned air to the cockpit through two floor outlets on either side of the pilot's compartment. The air is received from two sources; through a duct from the main cabin mixing valve and another from the cabin heater. Thus the cockpit can receive air warmer than that supplied to the cabin.

When on the ground with no superchargers running, outside air can be introduced to the cabin by blower through a check valve located in the side of the fuselage.

While the DC-7C, which cruises at 359 mph, uses an air cycle system because of weight requirements, the DC-8, with a speed in excess of 550 mph, uses a vapor cycle system. This is made possible by the availability of high energy air from the jet engines to drive compressors and fans.

In the future, as commercial planes attain even greater speeds, excessive skin temperatures due to air friction will create a severe structural heating problem. Some new method of cooling must therefore be found. Thermal research has already made great strides in this direction, and the eventual solution is certain.

The writer wishes to acknowledge the cooperation of the Douglas Aircraft Co. for permission to use material on the DC-7C and DC-8 aircraft.

# How To Find Proper Air Flow Rate For Industrial Solvent Dilution

By CLYDE F. METZLER
Chief Engineer
National Technical and Scientific Co.

TODAY a number of industrial operations employ processes which involve the extended use of solvents in quantity. Since the vapors produced by some of these solvents can be harmful in excessive concentrations, engineers concerned with the dilution of such vapors by ventilation should find the accompanying chart useful.

The nomograph permits easy determination of the air flow rate required to maintain a specified ventilation design concentration when the molecular weight of a solvent is known.

The data is based on the equation

$$C = 400\ (10^6)/MV$$

*where*

$C$ = required dilution rate (cfm of air per lb of solvent)
$M$ = solvent molecular weight
$V$ = ventilation design concentration (ppm)

The value of the ventilation concentration can be obtained from local ventilation codes, or from standard ventilation handbooks.

Also, threshold limit values (ppm) of various solvents for use in the industrial field are published annually by the American Medical Association.

**Example 1:**

What is the required dilution rate per lb of isopropyl alcohol having a molecular weight of 60, if the specified ventilation design concentration is 150 ppm?

*Solution*: Enter the chart at the left at the molecular weight of 60 and align this point with the ventilation design concentration of 150 ppm on the right. At the intersection of the central scale read the required dilution rate as 45,000 cfm of air per lb of solvent.

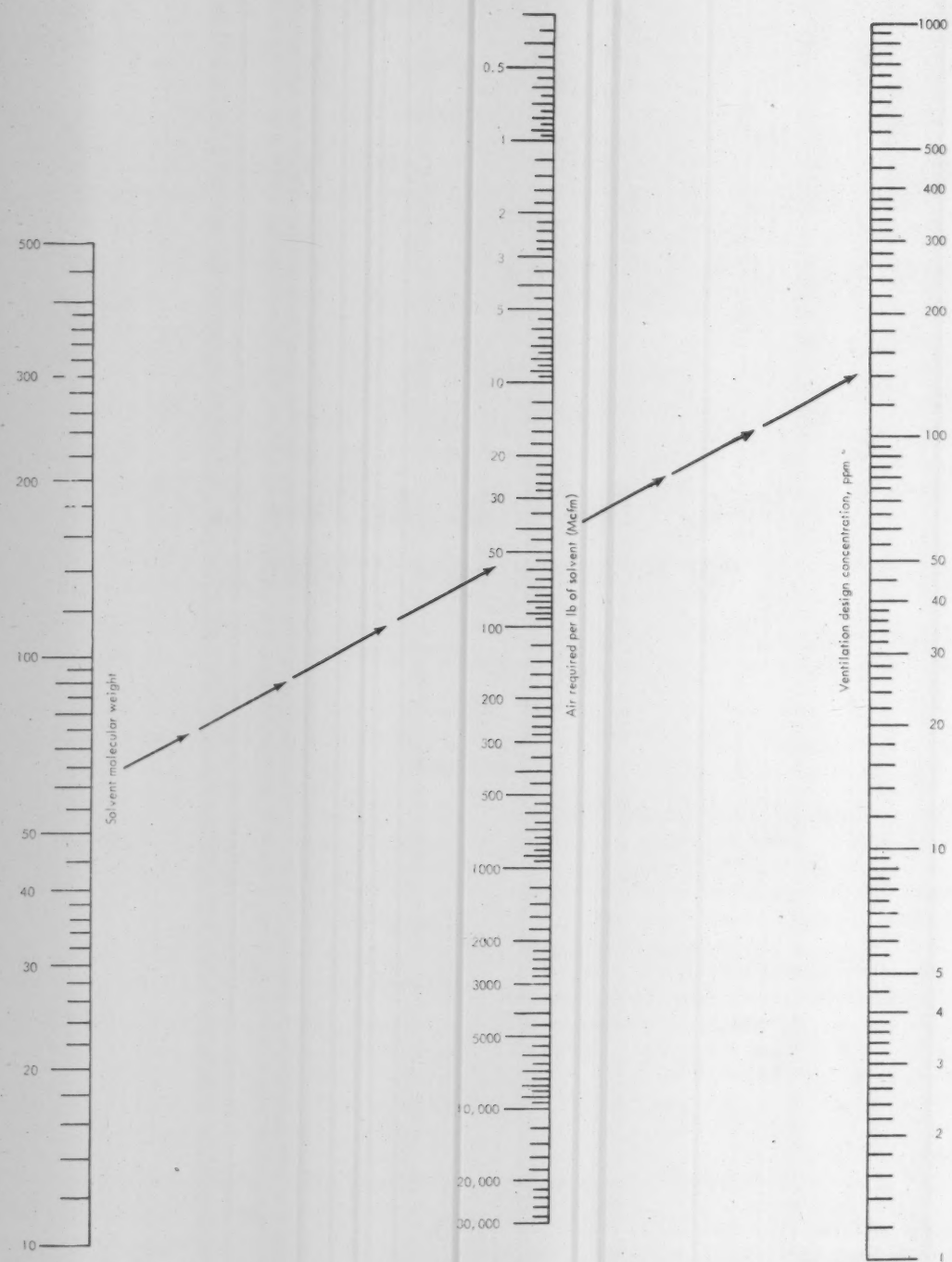
**Example 2:**

Determine the required dilution rate per lb of methanol having a molecular weight of 32 if the specified ventilation design concentration is 100 ppm.

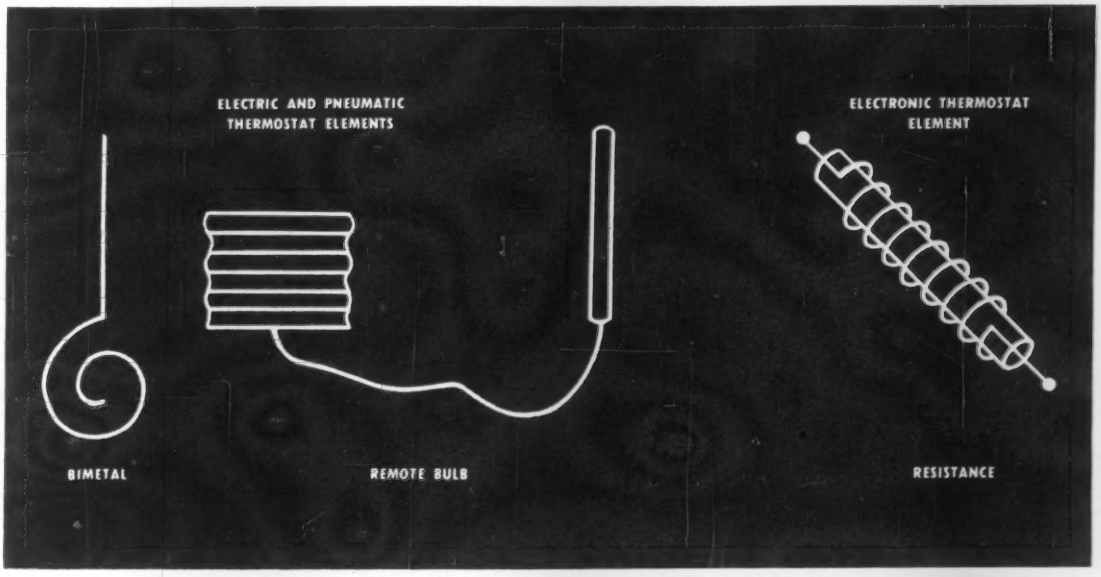
*Solution*: Align the molecular weight of methanol (32) with the ventilation design concentration (100 ppm). At the intersection with the central scale read the required dilution rate as 125,000 cfm per lb of solvent.

**Chart Applies to All Hood Designs**

This chart applies to the air flow through any type of hood, regardless of its configuration. The chart can be used also for installations where ventilation is provided by means other than a hood. ∓




NOMOGRAPH permits easy determination of the air flow rate required to maintain a specified ventilation design concentration of industrial solvents in air when the molecular weight of the solvent is known




**1** STARTING POINT for any control system is the local thermostat which initiates action to raise or lower temperature in response to varying room conditions. Electric and pneumatic thermostats use bimetal tongue or fluid charged bulb, shown at left and center, to initiate mechanical motion. Electronic system substitutes coil of wire as sensing element, as shown at right

What every engineer should know about

# Electronic Controls And How They Work

By JOHN SCHWARTZ
Automatic Controls Division
Barber-Colman Co.

• **Electronic controls for heating, cooling, and ventilating applications function on simple and reliable principles. Because of their widespread use, it is essential that the engineer who designs, installs, or maintains these devices know what they can do and what specifically should be expected of them. Therefore a fundamental knowledge of how and why they work is of lasting importance. This article gives that information.**

THE widespread application of electronic equipment in our fast-moving age suggests a need for awareness of electronic principles and the benefits which can accrue from the proper use of such devices.

Originally applied in the fringes of industrial and scientific progress, electronic methods now are commonplace in commercial and home environments. As used in air conditioning, heating, ventilating, and related areas, the fundamental circuits of electronic controls are easily understood.

## Review Facilitates Understanding

Electronic control knowledge can be gained by reviewing the simple bridge circuits used in electronic sensing systems. Amplifiers, which incorporate vacuum tubes and/or transistors, have enjoyed demonstrated reliability, and therefore may be considered as incidental. No discussion of vacuum tube opera-

tion is needed for a working knowledge of electronic control systems.

### Temperature Control Is Base

To simplify the presentation, general applications and operation will be described in terms of temperature control. Humidity and other variables are controlled by equipment which operates in a similar manner.

The success of electronic controls lies not so much in the components themselves, as in the methods used to control temperature and humidity.

For an easy understanding of how they work, let's compare electronic controls with other systems, using the thermostat as a starting place.

Electric and pneumatic thermostats use either a bimetal tongue or a fluid charged bulb to initiate mechanical motion (Fig. 1). Such movement closes an electric circuit, or controls the flow of air through a minute orifice. This effect is transmitted to an appropriate actuator through wires or pneumatic piping, and positions the actuator to admit more or less heat to the controlled area.

### Electronic Controls Use Coil

Electronic controls employ a coil of wire instead of the bimetal tongue or the bulb. The coil, or "sensing element," as it is called, is located in an appropiate enclosure in the room or medium being controlled. A two-wire connection to the coil completes a low voltage circuit to the other electronic components.

The electrical resistance of any wire varies with its temperature. Therefore, when room temperature falls, the resistance change affects the magnitude of current flowing in the circuit. A measurable amount of current is developed, which varies in proportion to temperature. There are no moving parts in such a device.

The electrical resistance characteristic of the wire, and its sensitivity to temperature change, is as absolute as the law of gravity. Variations in current flow initiated by temperature changes are used to operate a switching device. The switch contacts usually operate an electric valve or damper motor of the same type used in electric control systems.

### Wire Coil Yields Advantages

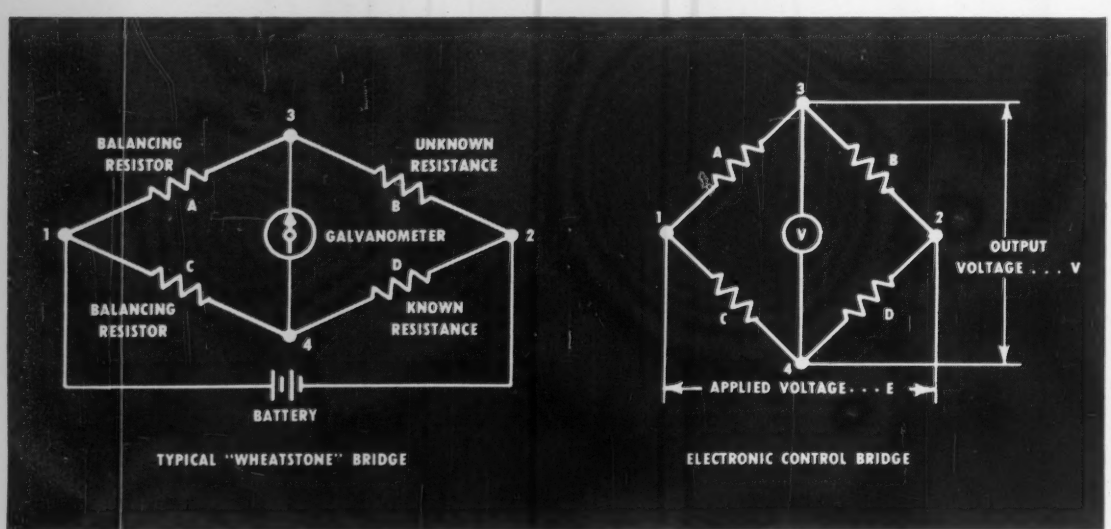
Among the characteristics of the small wire coil used as a temperature sensing device are the following:

1) Simplicity. The coil of wire has no moving parts, and one part replaces several. Lint, dust, moisture, and prying fingers have negligible effect on the dependability of its operation.

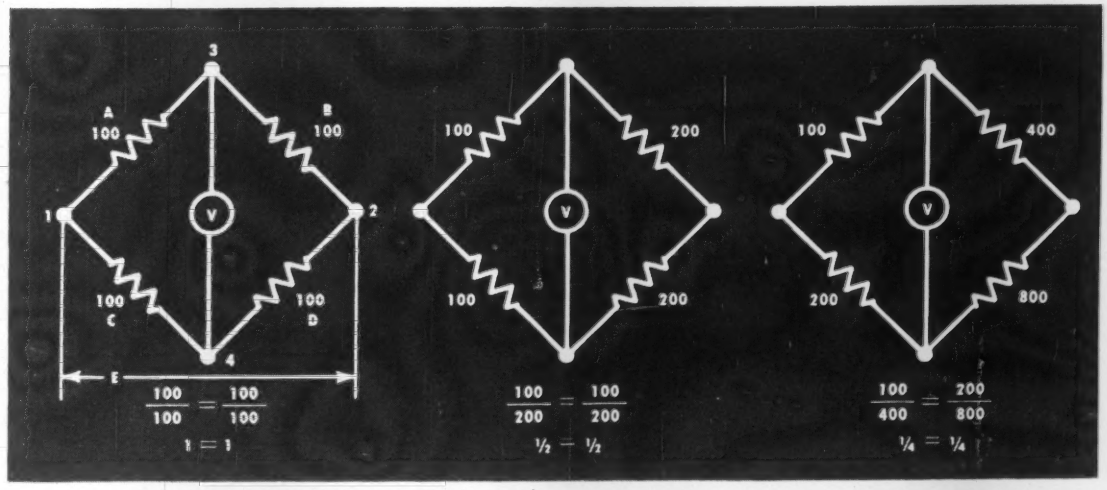
2) Rapid response. A low-mass coil responds instantaneously to minute temperature changes. Thermostat "lag" is reduced to a minimum.

3) Easy installation. Such a device requires only two low voltage, low current conductors to the sensing element.

4) Flexibility. The many combinations of electronic controls produce a wide range of systems to




**2-3** WHEATSTONE BRIDGE is diagrammed at left. Such a specific arrangement of resistances connected in a network is basis for electronic controls, as illustrated at right.




**4** THREE CIRCUITS, above, have widely different resistance values, but in each case *ratio* of resistance in bridge arms is the same, so that output voltage $V$ equals zero

meet individual job requirements. All variables which affect the controlled medium are harnessed, including outdoor, discharge air, and room temperatures.

The electronic control system functions as an integrating device which senses and evaluates changes as they relate to the conditions desired in the controlled space. Motorized valves and dampers are positioned automatically, and the need for re-positioning can be anticipated before changes are felt in the controlled space.

5) Versatility. New control sequences are possible, and can be easily accomplished with electronic equipment.

## Use Wheatstone Bridge Circuits

Circuits for electronic controls are based on principles of the Wheatstone bridge. This is a specific arrangement of resistances connected in a network.

The schematic diagram classically used to represent the circuit is shown in Fig. 2. Networks of this type are commonly used in testing laboratories to determine values of unknown resistances. The branches which form the diamond shape are often referred to as "arms."

Wheatstone bridges are activated by applying a source of voltage to points 1 and 2. An unknown resistance is inserted in arm $B$ and known resistance values are inserted in arm $D$ until the galvanometer deflection is zero. Voltage across points 3 to 4 then equals zero. When this condition of balance exists, the relationship among resistances is such that the ratio $A:B$ equals the ratio $C:D$.

In electronic control circuits the voltage developed at points 3 to 4 is the useful result of the application. A typical bridge circuit used in electronic control is shown in Fig. 3. A voltage, $E$, is applied to points 1 and 2. Depending on the ratio relationship just mentioned, a certain output voltage, $V$, appears at points 3 to 4. This voltage may have finite value, or it may be zero.

## Ratio Is Deciding Factor

It is the *ratio* of resistances that is important rather than their actual value. In Fig 4, three circuits are illustrated where resistance values are widely different. The ratios are maintained equal in all three; therefore, in each circuit, $V$ equals zero.

To satisfy the relationship $A:B$ equals $C:D$, or to keep the output voltage $V$, at zero, is the primary object of electronic instrument designers. By designing for control system balance at the control point when the bridge output voltage is zero, certain advantages are gained.

Operation at null point, or zero signal voltage, isolates the curcuit from variables such as changes in line voltage or the effect of aging vacuum tubes. There is no shift in control point caused by these or other variables.

## Review Basic Principles

We have reviewed these basic principles of electronic control operation: the wire coil sensing element is electrically used in one of the resistance arms of a bridge circuit. Then, as its resistance varies with room temperatures, the bridge output voltage changes in proportion. The circuit is usually adjusted so that the bridge voltage is zero when the room is at the desired temperature.

A typical bridge circuit used in electronic control systems is illustrated in Fig. 5. The sensing element

shown has a resistance value of 1000 ohms at 70 F. The value is arbitrary — it could be 100 ohms, or any other value, as long as the other resistances of the bridge are selected accordingly to preserve the ratio at equality. Here, fixed resistance values of 1000 ohms would form the other arms of the bridge.

### Variable Resistor Allows Calibration

A variable resistor provides the calibration adjustment and permits balancing of any slight difference in this or other circuit constants after the equipment is installed. Another variable resistor allows control point settngs over the full range required by the application.

The control point adjustment can be located in the sensing element or at the control cabinet which contains the bridge. Thus, adjustment can be made available to room occupants or it can be limited to authorized persons.

### Current Characteristic Important

Up to this point little has been said about the characteristic of the bridge supply voltage; viz. alternating or direct current. The initial diagram of the Wheatstone bridge, Fig. 2, would operate on d-c voltage supplied by the battery.

However, the circuit of Fig. 5 is an alternating current bridge, activated by a transformer voltage source.

Direct current bridges can be used, but amplification of the output of such a bridge would be more difficult. Also, d-c supply voltage is less easily obtained. In a d-c bridge, the output voltage changes not only in magnitude with temperature change at the sensing element, but also in polarity (plus or minus) depending on whether the temperature at the element rises above or falls below 70 F. In Fig. 6, the voltage relationships for a d-c bridge are graphically shown.

### A-C Bridges Commonly Used

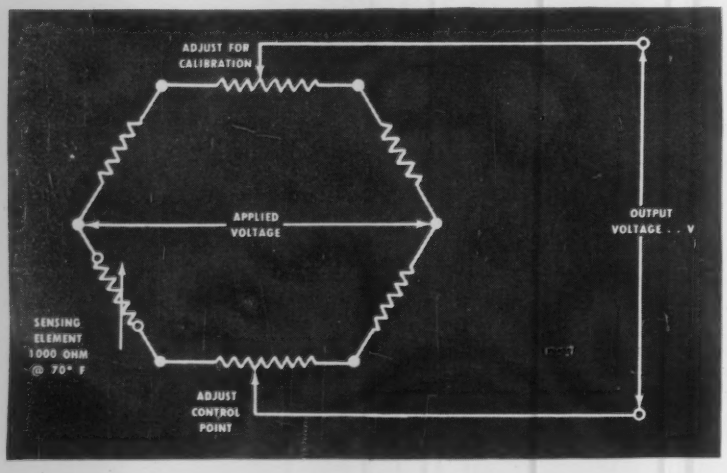
Because alternating current is supplied in lighting and power circuits, a-c bridges are used in most commercial control systems. When the bridge is energized by an a-c supply voltage, as in Fig. 5, an a-c output voltage results which changes in magnitude with temperature change at the element. Instead of becoming plus or minus, as in the case of the d-c circuits, the output changes its phase relationship with respect to the supply voltage.

Actually, an a-c voltage reverses its polarity many times per second — 60 times for our normal 60-cycle power. The phase relationship between two voltages or currents is determined by the alignment of the peaks, valleys, and null points of the two when they are superimposed, as in Figs. 7 and 8.

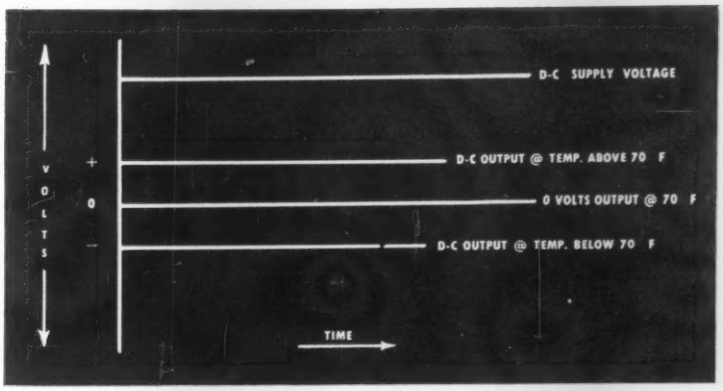
When the corresponding points on the curves are in line, the two quantities are said to be in phase (Fig. 7). When the correpsonding points are as shown in Fig. 8, the voltages are out of phase, in this case by 180 degrees of angular displacement.

### Coil Is System Heart

As previously mentioned, the sensing element is a coil of wire, the two ends of which are connected into the bridge circuit. The wire used in the manufacture of the sensing elements is likely to be a special alloy developed to obtain the properties desired.




**5** TYPICAL BRIDGE CIRCUIT used in electronic control systems. Resistance value is arbitrary, could be changed to any other value as long as resistance in other arm is changed also to preserve ratio at equality




**6** VOLTAGE RELATIONSHIPS for d-c bridge are shown at right. When temperature rises or falls from 70 F, output voltage not only varies in magnitude but also changes in polarity

Ordinary copper wire could be used, and in fact is employed in the elements of some measuring devices.

However, the alloy wire has considerably more resistance for a given size and length than does copper. Because of the higher resistance, less wire is needed in the winding of a sensing element. Therefore, such elements can be designed with the low mass required for fast response to temperature changes.

### Amplify Voltage Changes

The bridge circuit in Fig. 9 includes some changes and additions to that of Fig. 5. The sensing element is shown at a location remote from the bridge. Also, the electronic amplifier is indicated. An amplifier is used to magnify the small changes in bridge output voltage.

A room temperature sensing element may have 1000 ohms resistance at 70 F. Approximately 5 volts is applied to the element through the bridge circuit.

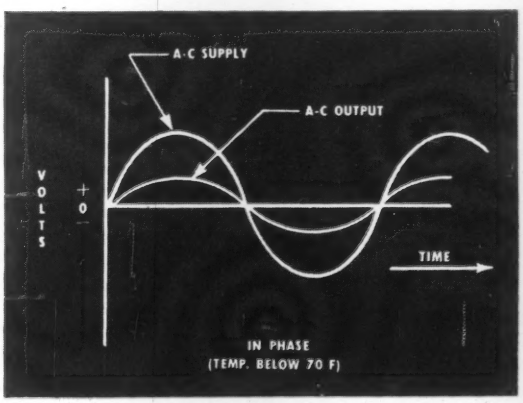
As an example of the result of this condition, assume the resistance of the sensing element changes 2 ohms when room temperature changes 1 F. If the temperature at the sensing element changed from 70 to 71 F, the bridge circuit would then be unbalanced because of the additional 2 ohms resistance created in the sensing element arm.

Due to this unbalance, the bridge output now changes from zero to a finite value. In this case, the bridge output would be about 5 millivolts (0.005 v). More generally stated, it can be said that the bridge output voltage varies in direct proportion to temperature change at the sensing element.

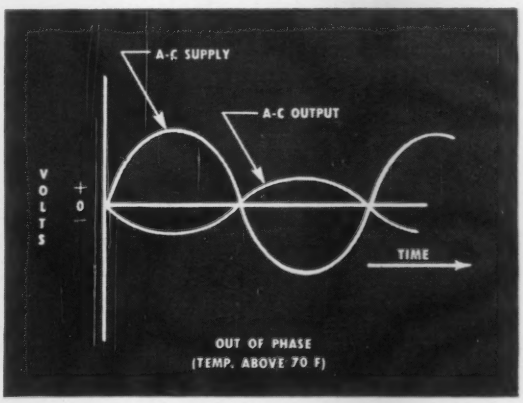
### Low Power Level Is Useful

Some important advantages of electronic controls for heating and air conditioning systems accrue through their ability to operate at minute power levels in the sensing element. An electronic amplifier therefore becomes an essential part of the system.

Bridge circuit output passes through the amplifier, as shown in Fig. 9, where it is increased in magnitude to the value required to operate a magnetic switch or relay. The electronic amplifier serves a function equivalent to the mechanical linkage or lever arms, springs, and pivot points of a pneumatic




**7** IN-PHASE relationship for two a-c voltages of continuously cycling power




**8** OUT-OF-PHASE relationship for a-c voltages. Here angular displacement is 180 degrees

system. In fact, those parts form what may be called a mechanical amplifier.

### Circuitry Is Familiar

Amplifier circuits and operation are similar to those employed for common radio receivers. Since the amplifiers used for electronic controls are basically voltage amplifiers, they are more simple than those used in radios, where response must accurately extend over a wide range of frequencies.

In circuits designed with the control point at zero volts output from the bridge, there is no shift in that control point as tubes age, and neither is there any effect from line voltage fluctuation.

### Amplifier Output Operates Relay

As may be gathered from the above, the output voltage of an amplifier operates an electric relay. Through its switching contacts, the relay directs the positioning of a control motor operator as required by changes in heating or cooling loads.

Quite possibly, the amplifier may include an override switch for manual positioning of the operator to permit temporary changes in valve or damper positions without disturbing the normal control point settings.

Such adjustments may be needed to satisfy temporary demands of occupancy or unusual ventilation requirements.

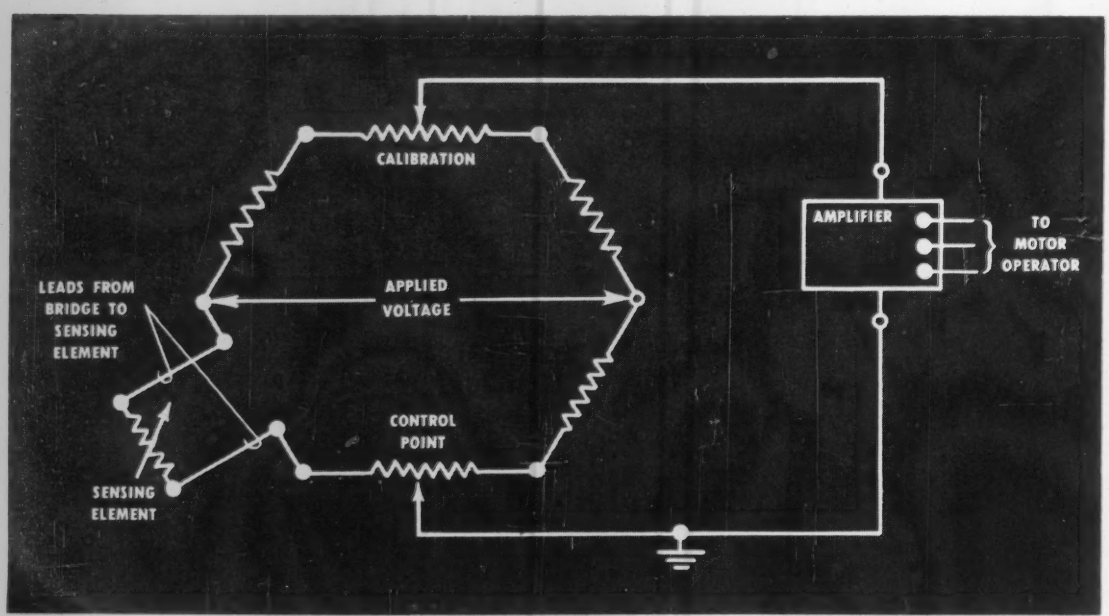
Also, the entire electronic portion of the control system is by-passed by the manual over-ride switch. The control motors can be placed under positive manual control of the switch whenever inspection or test operations are performed on the electronic components.

### List Good Design Requirements

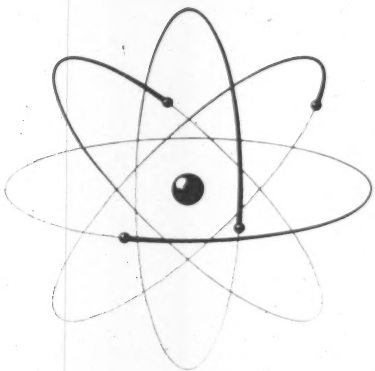
In view of the foregoing, we can now list those factors which comprise the important requirements for good electronic control designs. These may be summarized as follows:

A minimum number of vacuum tubes
A low tube operating voltage
A null voltage control point
A low mass in the sensing element
Low voltage sensing elements.

Succeeding articles will include a discussion of electronic control classification in terms of the type of action accomplished by the controls; to wit, proportional, floating, or two-position. We shall also discuss in more detail the function of electronics as applied to temperature control requirements, and investigate the many areas where electronic controls may be successfully used in the heating, piping and air conditioning field. ≠



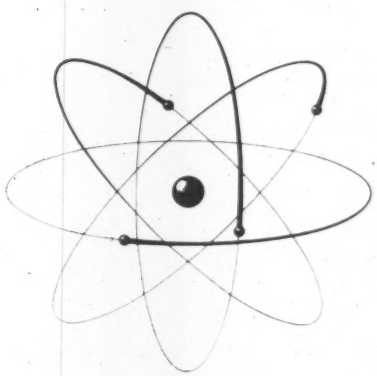

**9** BRIDGE CIRCUIT modified for electronic control purposes. Sensing element is shown at location remote from bridge, electronic amplifier is added to increase magnitude of circuit output in order to operate magnetic switch or relay settings.



# Piping Code Committee Interprets Nuclear Cases

**• Since the Code for Pressure Piping, ASA B31, was last issued, the Sectional Committee on the Code has been asked to interpret various statements contained therein. While these cases represent the opinion of the committee, they will not become parts of the Code until formal actions have been taken.**

**The following cases — N-3, N-4, and N-9, have been released for publication. Case N-9 was originally published in Heating, Piping & Air Conditioning in April of this year. It has been reopened, and the revised interpretation is presented here.**



### Case No. N-3 — Proposed Case on Screwed Connections

*Inquiry*: May screwed connections in which threads provide the only seal be used in nuclear piping systems?

*Reply*: It is the opinion of the Committee that screwed connections in which threads provide the only seal shall not be permitted in nuclear piping systems.

### Case No. N-4 — Proposed Case on Paragraph of Section 1

*Inquiry*: Sec. 1 Par. 121C limits the temperature of the hydrostatic media to 100 F maximum. May this limit be exceeded on nuclear piping systems?

*Reply*: It is the opinion of the Committee that, pending revision of Sec. 1, the 100 F maximum may be exceeded.

### Case No. N-9 (Reopened) — Centrifugally Cast Austenitic Steel Pipe for Nuclear Service

*Inquiry*: Under what conditions may centrifugally cast austenitic stainless steel pipe be used within the scope of Section 1 of the Code for Pressure Piping for nuclear service?

*Reply*: It is the opinion of the committee that the intent of the Code will be satisfied provided the following conditions are met:

1) Chemistry and mechanical property requirements:

# nuclear piping cases

a) The chemistry and tensile requirements shall be as given in ASTM A351. These shall be established from a sample ring cut from one end of each length of pipe, using the testing procedure given in ASTM Specification A-370.

b) The bending properties shall be established as required by ASTM A-376, Paragraphs 10 and 11.

2) Finish: The inside and outside surfaces shall be finish machined.

The material shall have a finish of 250 micro-in. RMS or 225 micro-in. AA or better.

3) Testing:

a) *Pressure test*: Each length of pipe shall be given a pressure test and shall show no leaks with the test pressure held for a period of 30 min per in. of wall thickness. The test pressure shall be at least 1½ times the rated pressure of the pipe at room temperature, except that the stress developed at the test pressure shall not exceed 90 percent of the specified minimum yield strength based on the actual wall thickness.

b) *Surface Inspection — Fluid Penetrant*: In addition to visual inspection, all surfaces of each length shall be inspected by the fluid penetrant method. The following standards of acceptance shall be met:

All linear discontinuities and aligned penetrant indications revealed by the test shall be removed. Aligned penetrant indications are those in which the average of the center-to-center distances between any one indication and the two adjacent indications in any straight line is less than 3/16 in.

All other discontinuities revealed on the surface need not be removed unless the discontinuities are also revealed by radiography, in which case the pertinent radiographic specifications shall apply.

c) *Radiography*: Each length of pipe shall be completely radiographed in accordance with ASTM E-94 and shall meet the requirements of ASTM E-71 for Class 2 quality casings.

4) Repair of Defects:

Defects disclosed by inspection and testing may be repaired by welding under the following conditions:

a) The defect shall be removed to sound metal and the surface of the cavity rendered clean.

b) Repair welding shall be done using procedures and operators that have been qualified in accordance with the requirements of ASTM A-376.

c) All repair welds shall be examined by the same procedures and to the same standards as the original cast material.

d) If the material had been heat treated before making the repair weld, the length shall be reheat treated.

5) Heat-Treatment:

Heat treatment shall consist of 1950 F minimum metal temperature and shall be cooled in air or liquid medium at a rapid rate.

6) Requirements after Hot-Forming Operations:

Pipe sections that have been subjected to hot forming operations such as bending, swaging, forging, van-stoning, and similar forming operations shall be reheat treated in accordance with Paragraph (5), and fluid penetrant tested.

7) Records:

a) Test Reports: Certified test reports shall give the results of the chemical and tensile properties, and shall specifically indicate that each of the other test requirements in this Case have been met. In the event that the inspector did not witness the removal and repair welding of any defects, the test report shall contain a statement as to the number, approximate extent, and location of such repairs.

b) All radiographs of original material and repaired areas shall be kept for a period of three years and shall be available to the inspector at all times.

Retests:

If the results of any chemical or mechanical tests do not conform to the requirements, retests shall be made on additional ring samples of double the original number, each of which shall conform to the requirements as specified.

Special Requirements:

It shall be the responsibility of the designer to require any or all of the following where service conditions or welding requirements warrant and when so specified becomes a requirement of this Case.

a) Where gaseous products of nuclear fission are anticipated, mass spectrometer or other gaseous leakage tests shall be specified.

b) Where cold-forming or hot-forming are to be considered, ductility shall be compatible with the type of forming.

Allowable Stress Values:

The maximum allowable stress, in psi, for use under this case shall be as given in the table:

| Temperature, F | Maximum allowable stress values in tension, psi, for ASTM A351 grade | | | | |
|---|---|---|---|---|---|
| | CF8 | CF8M | CF8C | CH20 | CK20 |
| Specific minimum tensile strengths | 70,000 | 70,000 | 70,000 | 70,000 | 65,000 |
| −20 to 100 | 17,500 | 17,500 | 17,500 | 17,500 | 16,250 |
| 200 | 15,700 | 16,900 | 17,000 | 16,100 | 15,500 |
| 300 | 14,250 | 16,300 | 15,600 | 15,150 | 14,900 |
| 400 | 13,100 | 16,300 | 14,200 | 14,600 | 14,600 |
| 500 | 12,200 | 15,900 | 13,000 | 14,550 | 14,550 |
| 600 | 11,700 | 15,350 | 12,200 | 14,450 | 14,450 |
| 650 | 11,500 | 15,000 | 11,900 | 14,400 | 14,400 |
| 700 | 11,300 | 14,700 | 11,700 | 14,350 | 14,350 |
| 750 | 11,100 | 14,350 | 11,600 | 14,300 | 14,300 |
| 800 | 10,900 | 14,000 | 11,500 | 14,150 | 14,150 |
| 850 | 10,650 | 13,500 | 11,350 | 13,900 | 13,900 |
| 900 | 10,400 | 13,000 | 11,200 | 13,500 | 13,500 |
| 950 | 10,100 | 12,350 | 11,100 | 12,500 | 12,500 |
| 1000 | 9,850 | 11,700 | 11,000 | 10,500 | 11,000 |
| 1050 | 9,600 | 10,600 | 10,900 | 8,500 | 9,750 |

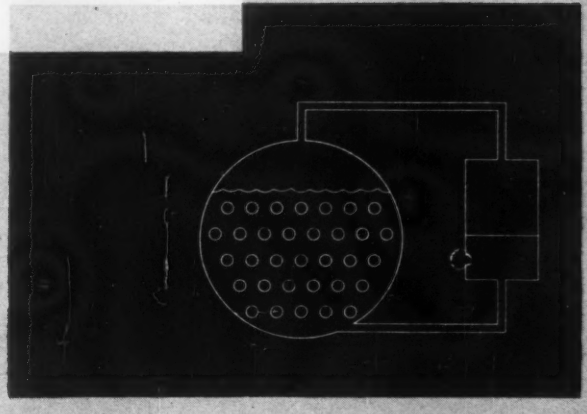
Note: These stress values are based on a casting quality factor of 1.00.

HPAC ENGINEERING DATA FILE

# How to Design and Operate FLOODED EVAPORATORS For Cooling Air and Liquids

- *System arrangements used*
- *How to separate liquid from vapor*
- *Advantages and disadvantages*
- *How to remove oil from refrigerant*
- *Steps that must be taken to defrost*
- *How to control the flooded system*

By W. F. Stoecker



# Consider These Factors When Designing and Operating "Flooded" Cooling Systems

A REFRIGERATION system with a flooded evaporator or a "flooded system" is defined herein as one in which the liquid level is controlled in the evaporator or in an auxiliary vessel such that the heat-transfer surfaces are wetted with liquid refrigerant. The flooded system is therefore distinguished from a system employing a thermostatic expansion valve which controls the superheat leaving the evaporator. The very nature of a valve which requires superheat for it to open will demand that a portion of the evaporator surface be dry.

One of the characteristics of a properly designed flooded system is that there is some recirculation of liquid refrigerant; thus, some liquid flows past the evaporator surface more than once before it finally evaporates. In the flooded systems referred to in this paper, the recirculation takes place by natural convection due to differences of refrigerant density in this circuit. Systems where recirculation occurs by virtue of mechanical pumps[1] are not covered by this article.

This paper describes flooded systems and discusses their operation and general design. The following topics are included: 1) description, 2) advantages, and disadvantages, 3) principles of circulation, 4) liquid-vapor separation, 5) surge drum design, 6) oil separation and return, 7) defrost, 8) control, and 9) application.

[1]*Numerals refer to references on page 158.*

**Refrigeration systems with flooded evaporators are used for both air cooling and liquid chilling. They are most popular at present in low temperature process cooling applications but find considerable use in chilling water for air conditioning.**

**In this report, the author describes the various types of flooded systems and shows how to design them. The information presented is of interest to both the designer and the operator of systems with flooded evaporators as it explains why a system functions as it does.**

**W. F. Stoecker is Associate Professor of Mechanical Engineering at the University of Illinois. The recipient of a National Science Foundation Fellowship, he is presently on leave from Illinois to study for his doctorate at Purdue University. Professor Stoecker has written extensively on refrigeration and air conditioning. His recently published book entitled *Refrigeration and Air Conditioning* is an analytical treatment of these subjects. He is a member of ASHRAE and until recently served as a member of the Research and Technical Committee.**

# Flooded System Arrangements Used

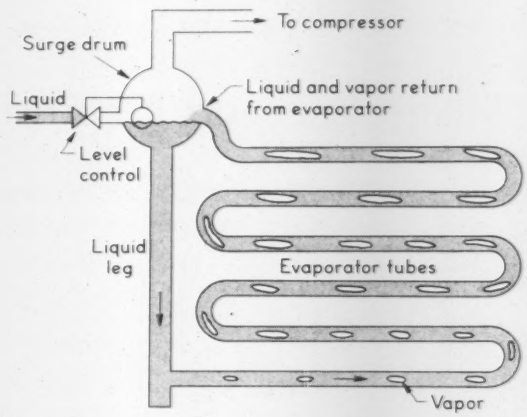
The principal arrangements of systems that employ flooded evaporators are: 1) refrigerant-in-tube evaporator using surge drum, and 2) liquid chiller with refrigerant in the shell. Fig. 1 shows a schematic arrangement of the first type — an evaporator for cooling air either by forced or natural convection. Figs. 2, 3, and 4 show variations of the second type where the refrigerant boils in the shell, thereby chilling a liquid.

## Refrigerant-In-Tube For Air Cooling

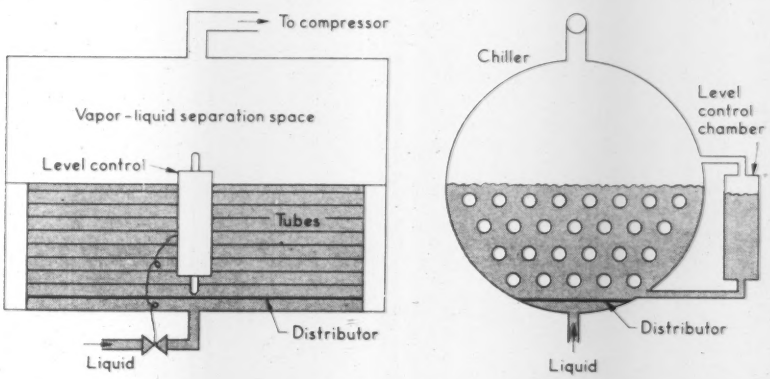
A level control regulates the flow of high-pressure liquid into the surge drum in the arrangement shown in Fig. 1. The flash gas resulting from the expansion flows out the suction line to the compressor and the liquid drops down the liquid leg to the bottom tube of the evaporator. In the evaporator tubes the heat absorbed by the evaporator vaporizes some of the liquid, and the liquid and vapor combination flows up through the evaporator tubes with some liquid spilling back into the surge drum. The liquid that is recirculated to the surge drum returns for another pass through the evaporator. Designers differ on the quantity of recirculation they try to achieve. Some designers try to achieve just slightly more than a 1-to-1 ratio (same flow entering evaporator as vaporizes in evaporator), while some attempt to achieve a circulation ratio of 10-to-1 or more.

## Flooded Liquid Chillers

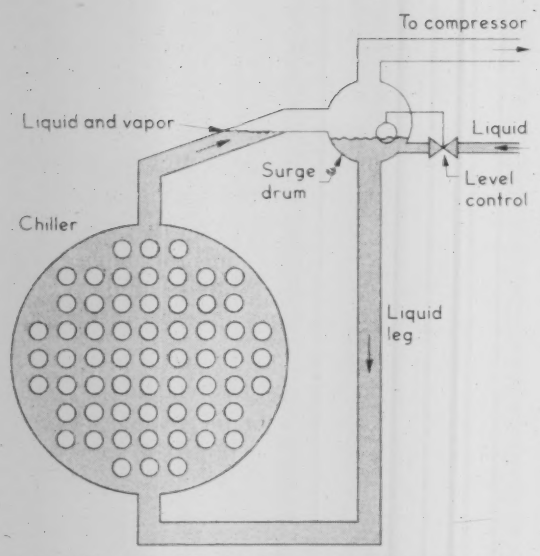
In Fig. 2, the level controller maintains a liquid level in the shell of the chiller such that all of the tubes are wetted with liquid refriger-




**1** AIR COOLING, flooded evaporator with refrigerant in tubes can be used for either forced or natural convection cooling. Surge drum absorbs changes in refrigerant volume and aids in separation of liquid from vapor




**2** REFRIGERANT-IN-SHELL evaporator with vapor separation space in shell above tube bundle is one of several flooded system arrangements used for liquid cooling




**3** LIQUID CHILLER shown here employs refrigerant-in-tube evaporator but surge drum replaces oversized shell for vapor separation

ant. The liquid enters the bottom of the shell and many manufacturers provide a distributor plate at the bottom to prevent the liquid and flash gas that enters the shell from "fountaining" directly up the center of the shell. The tubes in Fig. 2 occupy only the lower region of the shell — the upper portion provides space for the separation of liquid and vapor.

Fig. 3 shows a liquid chiller which uses a surge drum. The liquid level is controlled in the surge drum, and tubes occupy the complete shell since the liquid and vapor separation takes place in the surge drum.

Another version of the flooded liquid chiller is shown in Fig. 4 where a liquid-to-suction heat exchanger vaporizes the liquid which bubbles up from the shell of the chiller. Tubes occupy the entire shell in this arrangement. The liquid-to-suction heat exchanger is used particularly with Refrigerant 12 and Refrigerant 22 systems and not ammonia because each pound of warm liquid is capable of vaporizing more liquid in the suction gas with Refrigerant 12 and 22 systems than in an ammonia system. Also, ammonia systems are preferably operated with minimum superheat entering the compressor to prevent the inherently high discharge temperatures from increasing further.

# Advantages and Disadvantages of Flooded Systems

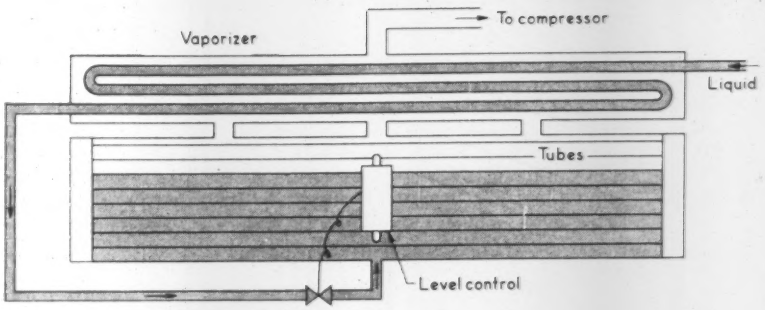
The advantages and disadvantages of one system must always be expressed relative to other possible arrangements. The flooded system competes principally with two other systems: 1) the one using superheat or thermostatic expansion valve control, and 2) the forced recirculation system.

## Comparison With Superheat Control

The flooded system has the following advantages. The evaporator surfaces are used more effectively because they are completely wetted. Problems in distributing the refrigerant in parallel-circuit evaporators are less severe. With the superheat control valve and distributor, even if a uniform distribution of refrigerant to the various parallel circuits is achieved, unequal loads on the individual circuits cause some of the circuits to be underfed and some overfed. The circuits in a flooded system more naturally accommodate themselves to their respective loads.

Another advantage of the flooded system is that in evaporators where the refrigerant is in the tubes, vapor-free liquid enters the evaporator which minimizes the pressure-drop. The flooded system can work more satisfactorily over a wider

*"Evaporator surfaces are used more effectively in the flooded system because they are completely wetted."*




**4** AUXILIARY VAPORIZER and liquid-subcooler arrangement is used with Refrigerants 12 and 22. Liquid-vapor refrigerant mixture from shell of evaporator flows upward through tubes carrying incoming liquid line to accomplish subcooling of the liquid and vaporization of the liquid from the evaporator

range of evaporating temperatures than does the superheat-controlled system which normally demands greater superheat at low evaporator temperatures unless a cross charge is used. When superheat-control valves must operate over a wide range of evaporating temperatures, multiple valves may be required, each for a particular portion of the operating range.

A feature of both the flooded system and the one with superheat control is that the static head from the level of liquid to the bottom of the evaporator raises the pressure and consequently the temperature in part of the evaporator. The mean-temperature difference between the refrigerant and substance being cooled is thereby reduced. Because the pressure drop due to friction in the tubes also requires a higher pressure at the bottom of the evaporator coil than the top, and since the superheat-controlled system usually experiences a higher pressure drop, the combined effect of static head and friction-pressure drop generally results in a smaller penalty in the flooded system than in the superheat-controlled system.

The disadvantages of the flooded system are that the level controls and surge drum (if it is used) have a greater initial cost than the superheat control. Flooded systems require a larger quantity of refrigerant to fill the evaporator and therefore a greater capacity of the receiver. Because of the larger charge of refrigerant, more time must be allowed to refill the evaporator after a hot-gas defrost. Oil-return problems arise in flooded systems using halocarbon refrigerants because at some point in the flooded system liquid drops are separated from refrigerant vapor. Oil as well as refrigerant is therefore retained in the evaporator. With a superheat control, the velocities can be maintained high enough to return oil to the compressor.

### Compare With Forced Recirculation

One advantage of the flooded system over the recirculation system using a mechanical pump is that it provides fewer maintenance problems. Also, in a forced recirculation system a standby pump may be necessary since that type of system will generally not function if the pump is out of service.

The advantages of the forced recirculation method over the flooded system are that there are fewer automatic valves to maintain, higher pressure-drop valves may be used, continuous recirculation is assured, and the system is easier to defrost. The heat transfer coefficients should be nearly the same in the forced recirculation system and a properly designed flooded system.

## How Refrigerant Circulates

In evaporators where the refrigerant is in the shell, like in Figs. 2 and 4, the liquid level should be maintained by the level control such that the tubes of the evaporator are immersed in liquid. In the evaporators of Figs. 1 and 3 where the level of liquid is regulated in a surge drum, a special circulation must prevail to assure complete wetting of the tubes. Flow of refrigerant down the liquid leg and up through the evaporator occurs because of differences in density of

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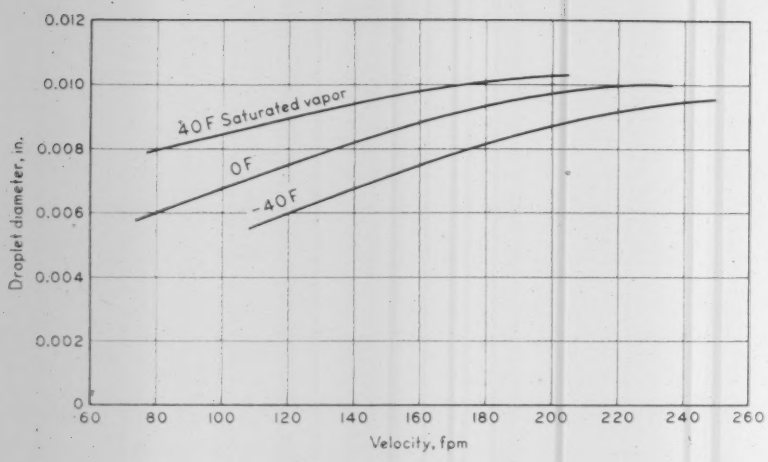



**5** CALCULATED velocities at which spherical droplets of ammonia will remain suspended in a stream of saturated vapor are plotted here. Equation 2 in text was used to calculate the data plotted here

refrigerant in the liquid leg and in the evaporator. In absorbing heat from the refrigerant load, some of the refrigerant in the evaporator vaporizes which causes the mixture of liquid and vapor to have a lower density than in the liquid leg. The refrigerant flows down the liquid leg and up through the evaporator at such a rate that the various drops in pressure due to flow just balance the pressure available due to differences in density.

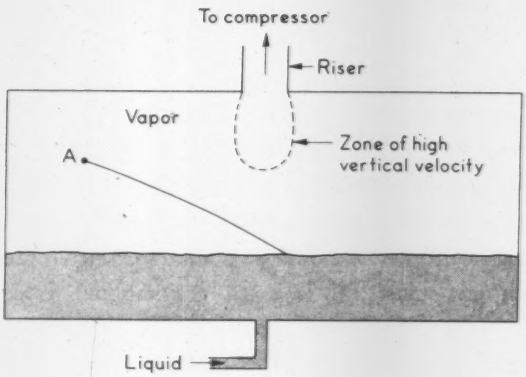
In a flooded system that is designed to circulate five pounds of refrigerant for each pound evaporated, for example, at refrigeration loads greater than design there will still be enough liquid carried out of the evaporator into the surge drum to assure complete wetting of all the evaporator surfaces. In an improperly designed flooded system, high loads demand an increased flow of refrigerant which results in a pressure drop so high that it would exceed the pressure available from the differences in density. When this happens, the level to which liquid is carried drops back into the evaporator and some of the tube surface is no longer wetted.

# How to Remove Liquid from Vapor

A crucial function which the flooded system must perform at some point is to remove liquid from the vapor that returns to the compressor. Without this separation, liquid carried over to the compressor may cause accelerated wear of the compressor and in extreme cases can result in damage to the plant and injury to employees. Liquid may be separated in the surge drum or in the chiller either by reducing the vapor velocities to the point that the liquid drops out, or by combining low vapor velocities with separation based on using centrifugal force. Centrifugal force aids separation when using such techniques as tangential inlet to the vessel or when requiring the liquid-vapor mixture to make changes in direction.

The problem of selecting a separation velocity is complicated by the fact that the droplets of liquid vary in size from extremely small to large. A given vertical velocity with a certain refrigerant and vapor density will allow all droplets over a certain diameter to settle out. Smaller droplets, however, will not be separated. Two important facts are still apparently unknown in the industry: what is the distribution of sizes of the droplets, and what is the maximum size of droplet or the quantity of liquid that is detrimental to compressor operation.

A common approach to this problem is to restrict the vapor velocities to values that have been found by experience to give no liquid carryover problems at the compressor. The general range of these maximum recommended vertical




**6** SEPARATION OF LIQUID from vapor flowing horizontally is represented here. Droplet at point *A* must fall rapidly enough to avoid zone of high vertical velocity which will carry it into suction line. This type of flow occurs in surge drums with their axes horizontal and in liquid chillers

velocities to achieve separation is between 100 and 200 fpm. Some designers use close to 200 fpm for all cases. Others use between 100 to 140 fpm unless they are confident that no extreme slopover conditions are to be encountered, in which case they design for slightly higher velocities.

## Separation in Upward Flow

A search for the fundamental principles underlying separation leads one to examine the drag forces on a sphere. If the vapor is flowing vertically upward it exerts an upward drag force on the spherical droplets. When the gravity force of the droplet is greater than the drag force, the droplet will settle to the bottom. The equilibrium condition of forces occurs when the gravity force balances the drag force represented by the following equation:

Gravity force, deducting buoyancy = Drag force

$$(\rho_L - \rho_v)(\pi d^3/6) = C_D\, \rho_v (V^2/2g)(\pi d^2/4) \quad \ldots [1]$$

*where*:

$\rho_L$ = density of liquid, lb per cu ft
$\rho_v$ = density of vapor, lb per cu ft
$d$ = diameter of droplet, ft
$C_D$ = drag coefficient, dimensionless
$V$ = velocity of vapor, fps

The drag coefficient, $C_D$, is a function of the Reynolds number and is available from experimental observations[2]. Equation [1] can be rewritten:

$$d = (3/4)\, C_D\, (V^2/g)\, [\rho_v/(\rho_L - \rho_v)] \quad \ldots [2]$$

This permits the calculation of the diameter of a droplet of liquid that can be suspended in a stream of vapor at a certain velocity. Fig. 5 is the graphical presentation of the separation velocities for ammonia calculated from equation [2]. If some certain size of droplet is taken to be the maximum desirable, 0.009 inches for example, the vapor velocities which carry droplets this size and smaller would be 120, 160 and 220 fpm if the saturated vapor is at 40 F, 0 F, and −40 F, respectively.

Another approach[3] is to group the terms in equation [1] in the following form:

$$V^2\rho_v/(\rho_L - \rho_v) = 4dg/3C_D \quad \ldots [3]$$

The group $V^2\rho_v/(\rho_L - \rho_v)$ with $V$ in fpm is then called the "carrying tendency" and from experience this term should be between 70 for small-diameter sections to 100 for large diameters. The carrying tendency may be as high as 400 when centrifugal separation is combined with low velocities. For a comparison between the carrying-tendency method with the separation velocities for ammonia shown in Fig. 5, a carrying tendency of 70 gives vapor velocities of 104, 162, and 274 at saturation temperatures of 40 F, 0 F, and −40 F, respectively. Fig. 5 indicates the maximum droplet size carried with these velocities to be between 0.009 and 0.01 inches.

Designers who prefer to work purely on the basis of velocities with no correction for the reduced carrying capacity of the less-dense vapor at low pressures point out that the compressor volumetric efficiency is more sensitive to the presence of liquid droplets at low suction pressures. They contend, therefore, that the maximum size of droplet should be smaller at low suction pressures.

### Separation in Horizontal Flow

The principles of drag forces must be applied somewhat differently for the case where the vapor which is carrying some droplets of liquid is flowing horizontally. Horizontal flow of vapor occurs in surge drums that have their axes horizontal and in liquid chillers. In order to settle out a droplet of liquid at point A in Fig. 6 the droplet must fall due to gravitational force rapidly enough that the horizontal velocity of the vapor does not carry it into the zone of high vertical velocity. The zone of high vertical velocity would appear to be an important region, because if the velocities were low enough here, the horizontal velocities would not have controlling influence on the separation. The vertical component of the velocity in the zone should be comparable to those recommended for separation with the vertical flow of vapor. Because the velocity in the shell in the neighborhood of the riser is less than that in the riser itself, maximum calculated velocities for separation of liquid drops can be higher than the 100-200 fpm range mentioned above if the velocities are based on the area of the suction line.

## Surge Drum Design

The purposes[4] of the surge drum are threefold: 1) to separate the liquid from the vapor, 2) to absorb changes in volume due to changes in load, 3) to absorb changes in volume due to sudden variations in suction pressure caused by more compressor capacity suddenly coming into service.

### How to Separate Liquid From Vapor

The principles of separation were discussed in the previous section. Some mention should be made of means to assist this separation other than by low velocities. Features that will aid liquid-vapor separation are placing the vapor line to the compressor as far as possible from the liquid-vapor return from the evaporator (two feet is generally the minimum recommended distance between these two pipes); use a tangential entrance of the liquid and vapor into the surge drum; or require the liquid-laden stream of vapor to make one or more changes in direction. The droplets of liquid tend to continue to flow in a straight line and are thereby thrown from the stream. Splitting of the flow between two or more suction outlets reduces the velocities and has been found successful in settling out liquid.

The use of centrifugal separation does not appear to have realized its full possibilities in flooded systems. More economical and compact systems would seem to be the reward for using centrifugal separation in preference to low vertical velocities for separation.

### Liquid Surges Due to Load Changes

The surge drum serves purposes 2 and 3 when it accommodates liquid that is suddenly pushed out of the evaporator. During steady-state operation of the flooded system a mixture of both liquid and vapor rise through the evaporator coils. If the load should suddenly increase, or if the suction pressure should suddenly drop, some of the liquid flashes into vapor and in doing so experiences a significant increase in specific volume. To accommodate this extra volume, liquid and vapor are pushed out both ends of the evaporator causing the liquid level to rise abruptly in the surge drum. To give some concept of the quantities of liquid pushed into the surge drum by variations in operating conditions, the following example illustrates the effect of a sudden change in suction pressure:

*Liquid Refrigerant 12 lies in an idle evaporator at 0 F. How much liquid will be forced out of the evaporator if the pressure is suddenly decreased 1 psi?*

The liquid has a specific volume of 0.011 cu ft per lb, but if the pressure is suddenly reduced by 1 psi, the expansion at constant internal energy vaporizes 0.55 percent of the liquid which raises the specific volume to 0.020 cu ft per lb. Approximately 45 percent of the liquid will be pushed out into the surge drum momentarily.

The illustration takes an extreme case with 100 percent liquid in the coil before the pres-

sure change. If the evaporator is operating, a considerable portion of the volume will already be occupied by vapor. The quantity of liquid displaced from the evaporator would consequently be a smaller percentage than shown. On the other hand, a 1 psi pressure change may be trivial compared to the change often experienced in plants.

### Guide For Surge Drum Sizing

Guides for sizing the surge drum generally express the free volume (that volume between the controlled liquid level and the upper surface of the drum) as a function of the evaporator volume. The following range of volume ratios are generally followed:

1) For applications where load and pressure variations are light.

Free volume = 0.3 × evaporator volume

2) For finned coil units, for systems with great variations in load or pressures, and for applications where the temperature control closes off the suction line permitting liquid to back up from evaporator into the surge drum.

Free volume = 1.0 × evaporator volume

The multiplying factor for a finned air-cooling coil is normally about twice that of bare pipe even though for a given heat-transfer duty the finned coil has a smaller evaporator volume. This is because the greater intensity of heat transfer per lineal foot of pipe in the finned coil makes it more sensitive to changes in load.

## Oil Separation and Return

All reciprocating compressors when properly lubricated eject some oil with the discharge gas. This oil flows along with the discharge gas to the condenser and then along with the liquid refrigerant through the expansion valve into the evaporator. The very design of flooded systems which seeks to achieve separation of liquid also prevents the oil from entering the suction line and returning to the compressor. Oil separators in the discharge line are recommended, but they are never 100 percent effective, so some means must be provided for extracting the oil from the evaporator. Oil behaves differently with ammonia than with the halocarbon refrigerants, so oil problems will be treated separately for these two classes of refrigerants.

### Oil Removal in Ammonia Systems

Oil is nonmiscible and is heavier than ammonia. Oil will therefore separate and sink to the bottom of any vessel where the liquid is relatively undisturbed. One of the most popular locations to collect oil in an ammonia system is in the liquid leg. The leg is extended below the takeoff to the evaporators and the oil drained from the low point. Another way, particularly with liquid chillers, is to provide a pot at the bottom of the shell where the oil can collect and be periodically drained off.

Draining the oil from a low-temperature collection point is not always easy because the oil at the low temperature is viscous, and opening the drain valve may only spurt out a little oil — the rest of it clinging to the sides of the pot or oil leg. Warming up the system before draining is effective when it is possible, and when not possible, a heated still may be used.

### Oil is Soluble in Halocarbons

Oil is quite soluble in Refrigerant 12 and to a lesser extent in Refrigerant 22. Fig. 7 shows the solubilities[5] of a refrigerant oil in Refrigerants 12 and 22. If, for example, Refrigerant 22 contains 5 percent oil in solution, the oil remains in solution until the temperature drops to about 0 F at which temperature some begins to separate. Refrigerant 12, on the other hand, retains a high solubility of oil until its temperature drops to about −50 F.

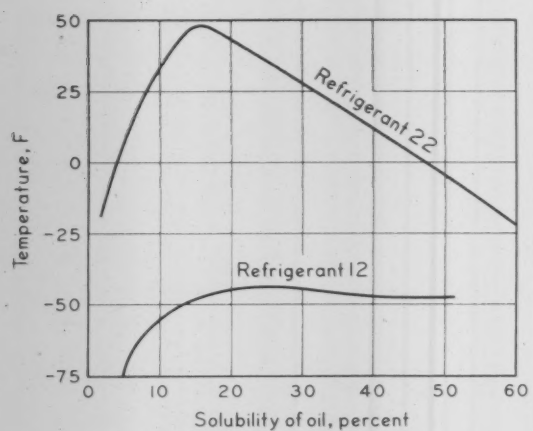
What is the effect of oil in the evaporator? The effect of both dissolved and free oil is generally detrimental. With Refrigerant 12, oil raises the boiling point one degree for each 5 percent of oil in solution[6]. Both dissolved and

undissolved oil reduce the heat transfer coefficient. One engineer also reported that when a new system employing a liquid chiller was started up, the bubbles broke cleanly from the liquid refrigerant surface in the evaporator. Some time later there was considerable frothing in the chiller, probably due to the buildup of oil concentration.

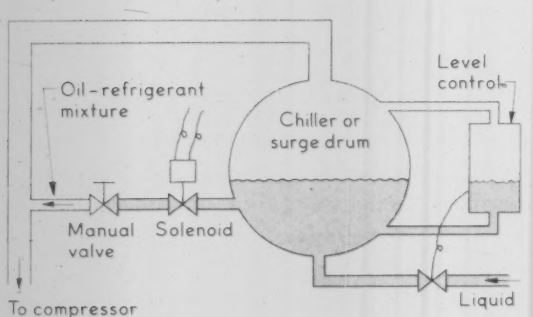
## Four Popular Oil Recovery Devices

There are numerous types and variations of types of oil recovery devices. Some of the popular ones are:

1) Direct drain into suction line,




**7** SOLUBILITY OF OIL in Refrigerants 12 and 22 is relatively high as indicated here. Provision must be made to separate oil from oil-refrigerant mixtures and to drain it to the compressor to maintain satisfactory operation




**8** DIRECT DRAIN of oil to the suction line is one of four ways to recover oil in flooded systems. Heat from the environment or a liquid-suction heat exchanger is required to vaporize the liquid refrigerant so drained. Vapor velocity carries oil back to the compressor

2) Drain through liquid heat exchanger,

3) Drain through an electric heater,

4) Percolator to elevated suction line and compressor.

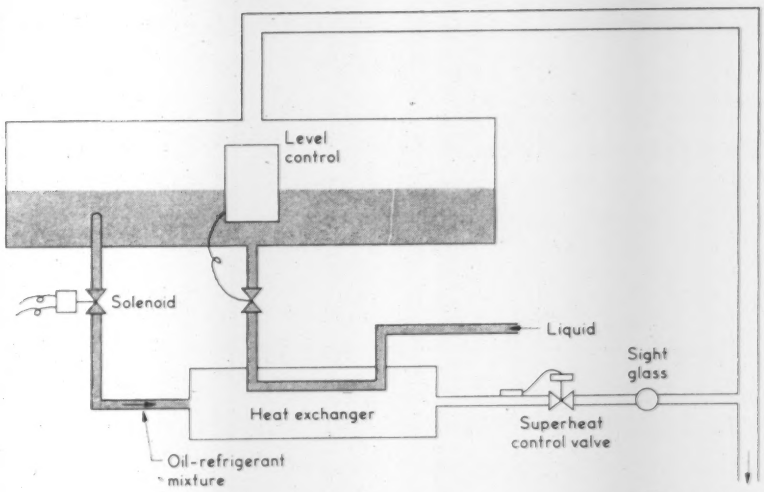
All the methods operate on the principle of removing a sample of oil-rich liquid refrigerant from the evaporator, surge drum, liquid leg, float chamber, or combinations of these positions and either draining the oil directly to the compressor or separating the oil first and then draining it to the compressor. A solenoid valve should always be installed in the drain line to close when the compressor is not operating and prevent liquid refrigerant from draining during idle periods.

## Direct Drain to Suction

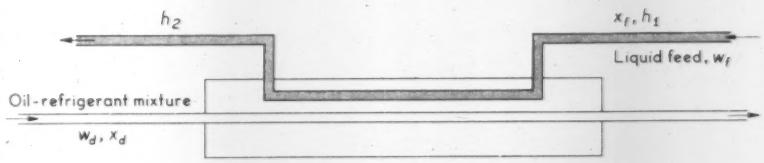
The direct drain into the suction line, Fig. 8, is probably one of the simplest of the methods, but requires heating in the suction line either from the environment or from a liquid-suction heat exchanger in order to assure the vaporization of the liquid refrigerant. Once the oil has been introduced into the suction line, the vapor velocity is generally high enough to carry it back to the compressor.

## Drain Through Heat Exchanger

When the compressor is below the evaporator, the oil-rich refrigerant mixture may be sent through a heat exchanger where the heat from the liquid feed coming to the evaporator boils away the liquid refrigerant from the oil. Fig. 9 shows such an arrangement. Since the pressure in the suction line is only slightly lower than in the evaporator, flow of the refrigerant-oil stream must take place principally by gravity. A thermostatic expansion valve regulates the flow of refrigerant-oil mixture and the bulb is placed before the valve to regulate the superheat leaving the heat exchanger. The normal application of the thermostatic expansion valve is for delivering liquid with an appreciable pressure difference over the valve. In this application, however, the valve handles vapor in addition to the liquid oil and the pressure drop across the valve must be low. Recommended




**9** OIL RETURN by draining oil-refrigerant mixture through a heat exchanger is illustrated here. Heat in incoming liquid vaporizes refrigerant to prevent return of liquid to compressor




**10** OIL CONCENTRATION in evaporator can be calculated for system like that of Fig. 9 by taking a heat and oil balance about the heat exchanger at points shown here

orifice sizes for this valve[3] are as follows:

| Capacity, tons | Orifice size, in. |
|---|---|
| 10-20 | 1/4 |
| 21-45 | 1/4 |
| 46-75 | 5/16 |
| 76-100 | 3/8 |
| 101-200 | 7/16 |

Another possibility is to locate the thermostatic expansion valve in the oil-refrigerant line before the heat exchanger, leaving the bulb at its location shown in Fig. 9. The valve does not need to pass vapor with this arrangement.

A variation of the oil-return system in Fig. 9 is to place a tee between the sight glass and the entrance to the suction line. The upper leg of this tee connects to a line going upward which carries the vapor to a higher point in the suction line, and the lower leg of the tee drains oil to the compressor crankcase.

## How to Calculate Oil Concentration

The concentration of oil in the evaporator can be calculated for the oil return system in Fig. 9 if operating temperatures and the oil concentration in the liquid feed to the evaporator are known. Referring to Fig. 10, the following terms are defined:

$x_f$ = percent oil in liquid refrigerant to evaporator
$w_f$ = rate of flow of liquid refrigerant, lb per hr
$h_1$ = enthalpy of liquid refrigerant entering heat exchanger, Btu per lb
$h_2$ = enthalpy of liquid refrigerant leaving heat exchanger, Btu per lb
$x_d$ = percent oil in oil-refrigerant drain which is also the concentration of oil in the evaporator
$w_d$ = rate of oil-refrigerant drain, lb per hr
$h_{fg}$ = latent heat of evaporation of liquid refrigerant at evaporator temperature, Btu per lb

A heat balance about the heat exchanger gives:

$$w_f\,(h_1 - h_2) = h_{fg}\,w_d\,(100 - x_d)/100$$

or,

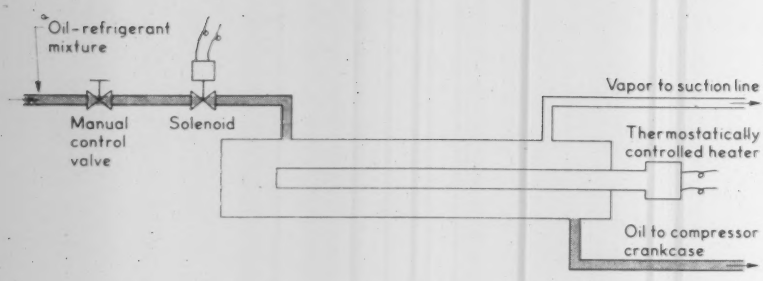
$$w_f/w_d = h_{fg}(100 - x_d)/(h_1 - h_2)100$$

An oil balance about the evaporator gives:

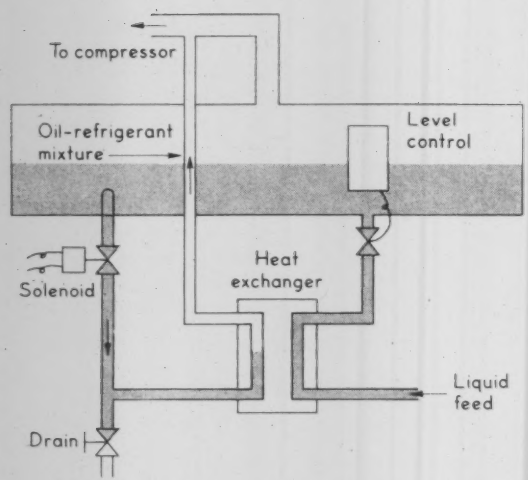
$$w_d x_d/100 = w_f x_f/100$$

Combining,

$$\begin{aligned} x_d &= w_f x_f/w_d \\ &= x_f h_{fg}\,(100 - x_d)/(h_1 - h_2)100 \\ &= [100\,x_f h_{fg}/(h_1 - h_2)]/[100 \\ &\quad + x_f h_{fg}/(h_1 - h_2)] \quad \ldots\ldots[4] \end{aligned}$$




**11** ELECTRIC HEATER may also be used to separate oil and refrigerant. This system is similar to that of Fig. 9 except that heat required for vaporization is added electrically




**12** OIL SEPARATION and return when the compressor is above the evaporator is shown here. Boiling refrigerant percolates oil out of heat exchanger and up to suction line. Provision should be made to drain oil from heat exchanger in the event percolation fails to lift the oil

*Example*:

Calculate the oil concentration in the evaporator of a Refrigerant 22 system with an evaporating temperature of 10 F if liquid feed at 96 F enters the heat exchanger and leaves at 50 F. The oil concentration in the discharge gas from the compressor is 4 percent, and the oil separator is 60 percent efficient.

*Solution*:

$h_1$ = 39.7 Btu per lb at 96 F
$h_2$ = 24.7 Btu per lb at 50 F
$h_{fg}$ = 92.8 Btu per lb at 10 F
$x_t$ = 4 − 4(0.6) = 1.6 percent
$x_d$ = [1.6 × 100 × 92.8/(39.7 − 24.7]/[100 + 1.6 × 92.8/(39.7 − 24.7)]
= 9.0 percent (concentration of oil in evaporator)

## Drain Through Electric Heater

Oil may also be returned when the compressor is at a lower elevation by draining the oil-refrigerant mixture through an electric heater as illustrated schematically in Fig. 11. The system in Fig. 11 is similar to the one in Fig. 9 except for the method of applying heat to vaporize the refrigerant from the oil. This system has the disadvantage of the cost of the electricity as well as the additional cost of refrigeration to compensate for the heat introduced by the electric heater. With the system in Fig. 9, the heat needed to vaporize the refrigerant is recovered by cooling the liquid feed. On the other hand, the liquid heat exchanger method in Fig. 9 is limited in the quantity of oil-refrigerant mixture that it can drain — a limitation that can be circumvented with the electric heater.

## Percolate Oil to Overhead Suction

The method of oil separation[7] shown in Fig. 12 is designed for the situation where the compressor is at a higher elevation than the evaporator. The system operates on the principle of percolation in somewhat the same manner as recirculation occurs in the flooded system with a refrigerant-in-tube evaporator. The system in Fig. 12 employs a heat exchanger where the refrigerant is vaporized from the oil by the liquid feed as in Fig. 9. The arrangement is such, however, that the boiling of the refrigerant in the heat exchanger percolates the oil (and perhaps some refrigerant) up to the suction line. If percolation is insufficient to carry the oil completely up to the suction line, the heat exchanger will become logged with oil and provisions are made for draining.

## Where to Drain Oil

A final word should be mentioned as to the proper position from which to drain the oil-refrigerant mixture from the low side of the sys-

tem. Depending upon the refrigerant and the conditions, the position of the oil drain is either important or immaterial. In Refrigerant 22 systems operating below 0 F the oil separates, and being lighter than the refrigerant it rises to the top. The oil drain should therefore be located at the surface of the liquid level. In Refrigerant 22 systems operating at high temperatures and in Refrigerant 12 systems because of the miscibility of the oil and the turbulence in the evaporator and surge drum, the oil will be quite thoroughly distributed throughout the vessels. The position of the drain in the vessel under the latter conditions appears to be immaterial, therefore, so long as the position is one where liquid and not vapor is tapped off.

# How To Defrost Flooded Evaporators

Besides merely scraping the frost from the evaporator surfaces, the two principal methods of defrosting air coils are: 1) the hot gas defrost, and 2) the water defrost. To accomplish a hot-gas defrost the steps are: a) shut off liquid feed to the surge drum, b) eliminate the liquid from the evaporator and isolate evaporator, c) send hot-gas to the evaporator, continuously removing the condensed liquid if possible, and d) revert to cooling operation when defrosting is complete.

## Three Steps in Water Defrost

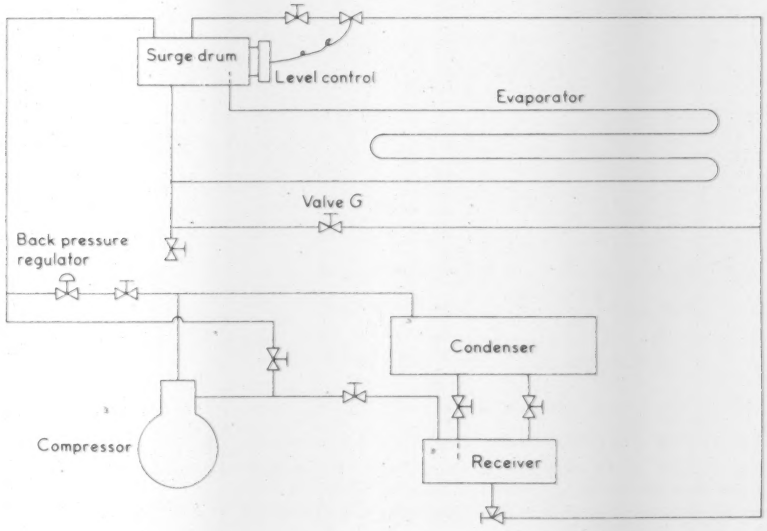
The steps in performing a water defrost[8] are: a) shut off liquid feed to the surge drum, b) apply water for defrost, and c) when defrost is complete, carefully revert to cooling operation. If convenient, the liquid refrigerant may be removed from the evaporator before applying water on the external surfaces, although it is not absolutely necessary. The defrosting load is increased slightly if the liquid refrigerant in the evaporator must be warmed.

## Four Ways to Remove Liquid

Removing the liquid from the evaporator can generally be accomplished by one of the following ways:

1) Applying discharge pressure to the evaporator and forcing the liquid to the receiver on which is applied suction pressure[9] (Fig. 13 illustrates this method which is applicable only with single evaporators because other evaporators would not be fed when the receiver pressure is reduced)

2) Forcing the liquid to a trap in the suction




**13** HOT GAS DEFROST piping arrangement for flooded systems is shown here. Liquid in the evaporator is removed through valve *G* into receiver which is under low pressure during defrost

line either through a direct connection or through the suction line, then pumping the liquid to the receiver

3) Forcing the liquid from the evaporator into the surge drum (the surge drum must be adequately sized for this operation)

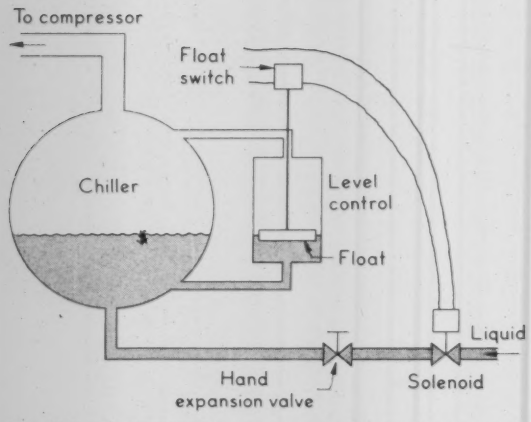
4) Pumping the refrigerant out of the evaporator with the compressor (this operation will require considerable time in certain types of evaporators).

# How To Control Flooded Systems

The two chief control assignments in flooded systems are: 1) level control, and 2) temperature control. One of the characteristics of flooded systems is the control of the liquid level in the evaporator or surge drum. Proper liquid-level control is therefore essential to effective operation of the system. Some type of temperature control is also necessary, although often some variation in temperature is permissible.

## Four Types of Level Control

Most of the commonly used level controllers fit into one of the following categories: a) direct-acting float valve, b) float switch electrically opening and closing a valve, c) superheat control valve with electrically-heated bulb, and d) high-side float valve. The first three controls mentioned are called "low-side valves" because they control the liquid level on a low-pressure vessel. The controls may either have their level sensing element in the vessel where the level is being controlled, or the level may be sensed in a float chamber external to the vessel and connected to the vessel by two pipes, one above and one below the liquid level.



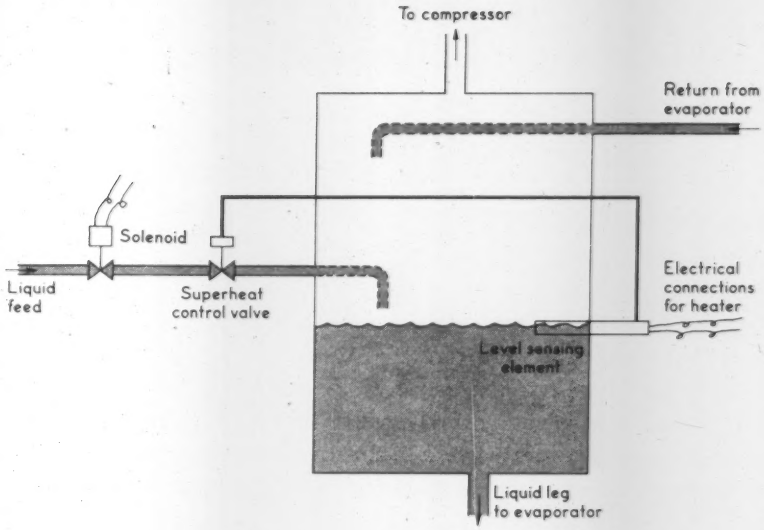

**14** FLOAT SWITCH arrangement for level control is shown here. Hand expansion valve, set to feed slightly more than maximum evaporator liquid requirements, minimizes pressure fluctuations in surge drum and evaporator

The direct-acting float valve opens and closes the valve by means of linkages directly connected to the float.

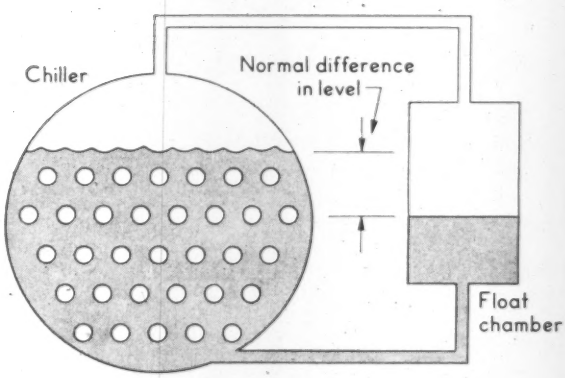
The float switch, as shown schematically in Fig. 14, closes electrical contacts upon a drop in the liquid level below the control point. Electrical current then flows to a solenoid valve which opens until the float rises to a point that the switch interrupts the circuit. The flow of liquid should be restricted by a hand expansion valve which is set to feed slightly greater than the maximum flow required by the evaporator. Without the hand expansion valve, fluctuations of pressure in the surge drum and evaporator will be sudden, and accelerated erosion will occur in the seat of the solenoid valve.

The superheat control valve with an electrically-heated bulb, Fig. 15, revises the usual application of the superheat control valve by fitting the heating element into the bulb which in turn is inserted in the vessel or float chamber where the level is to be controlled. The heater is so designed that the heat input is balanced by heat transfer to the liquid at partial immersion of the bulb. The valve thereby modulates the flow of liquid to partially immerse the level sensing element.

The high-side float valve maintains a constant liquid level in a high-side vessel or in its own float chamber. It consequently feeds to the evaporator as much liquid as its level-control vessel receives. With a high-side float valve, the storage of excess refrigerant should be on the low side rather than in a high-side receiver. One drawback of the high-side float is that it can be used only in systems with single evaporators.




**15** LEVEL CONTROL with a superheat control valve is illustrated here. Control valve bulb is electrically heated and designed so heat input is balanced by heat transfer to liquid at partial immersion of the bulb. Valve modulates flow to keep bulb partially immersed




**16** FLOAT CHAMBER on liquid chiller requires careful design. Sudden increases in load raise the liquid level in the chiller. Oil in the float chamber lowers level in chiller in halocarbon refrigerant systems but raises level with ammonia. Provision to drain oil from chamber should be made

## Locate Control Carefully

The level-sensing element when placed in the vessel whose level is being controlled should not be located where liquid from the liquid feed line or liquid from the evaporator can splash on it. In a direct acting float valve erratic performance results and usually unnecessary erosion of the seat. In the float switch system, the solenoid will snap on and off unnecessarily, and in the superheat control the sensing element cannot perceive the proper level. Sometimes a baffle between the entering liquid stream and the level sensing element may be desirable.

## Factors in Float Chamber Design

Several recommendations are in order for the float chamber. In Fig. 16, a float chamber is connected to a liquid chiller. Because the liquid in the chiller is boiling, it embraces bubbles of vapor which make it less dense than the liquid in the float chamber. The level in the chiller will consequently rise above that in the chamber. A sudden increase in load makes the mixture in the chiller still less dense which causes its level to rise even more. Another factor that influences the relative levels is oil which collects in the float chamber. A mixture of oil and refrigerant enters the float chamber at the bottom, the refrigerant progressively boils away, and the remaining liquid possesses a high concentration of oil. With the halocarbons, the oil is lighter than the refrigerant so the liquid level in the chiller drops. With ammonia the effect is the opposite. Provision should be made for removal

of the oil from the float chamber such as by tying in the chamber to the oil bleed-off system.

### Three Ways to Control Temperature

Temperature control in a flooded system can generally be achieved in one of the following fashions: 1) regulate the suction pressure, 2) control the liquid feed, or 3) cycle the blower of an air coil.

A rough form of temperature control is to keep the suction pressure constant. When the temperature of the refrigerated substance reaches the saturation temperature corresponding to this pressure, heat transfer ceases. When the temperature of the refrigerated substance increases, heat flow to the evaporator resumes. A more precise form of temperature control is to use a temperature-sensing bulb to reset the evaporator pressure regulator setting.

Temperature control may also be achieved in flooded systems by installing a regulating valve at either the inlet or outlet of the evaporator. In either of these locations the pressure drop must be small because the liquid circulation in the flooded system takes place by natural convection. Pilot-operated valves or valves whose seats are opened by a direct mechanical magnetic linkage are therefore essential. The valve placed at the inlet location does not give immediate control of the temperature because the liquid in the evaporator continues to evaporate. The valve in the outlet of the evaporator provides prompt control since it can quickly use the continuously-forming vapor to push liquid back out of the evaporator. The surge drum must be designed with this possibility in mind.

The third method of temperature control is applicable to forced convection air-cooling coils. A thermostat can control the blower operation, and a solenoid valve in the liquid line should close when the blower stops. Without this valve, when the blower shuts off, boiling will virtually stop and leave a low level of liquid in the evaporator. The level control fills the evaporator again, but then when the blower resumes operation the heat load boils liquid violently out of the evaporator.

## Where Flooded Systems Are Applied

Flooded systems have found their greatest application so far in low-temperature, industrial cooling applications. The improved heat-transfer effectiveness of the flooded system is more prominent in low temperatures where the mean-temperature difference between the product and refrigerant becomes increasingly important. Flooded systems in the higher temperature range have mostly appeared in the form of flooded water chillers. The improvement in the heat-transfer effectiveness achieved by the flooded system is due principally to the complete wetting of the evaporator surfaces and to the improved distribution of refrigerant in parallel circuit evaporators at a rate proportional to the load in any particular circuit.

*[The author enjoyed the full cooperation of numerous industry engineers in the preparation of this paper, including Messrs. Leon Buehler, Jr., of Creamery Package Manufacturing Company, Charles Hansen III of Refrigerating Specialties Co., J. R. Harnish of York Division of Borg-Warner Corporation, E. J. Kocher and M. F. Takach of Vilter Manufacturing Company, W. H. Krack and D. Rentschler of Sporlan Valve Company, M. A. Ramsey of Worthington Corporation, W. V. Richards of H. A. Phillips & Co., George T. Weick of E. L. Nickell Company, and D. D. Wile of Recold Corporation.]*

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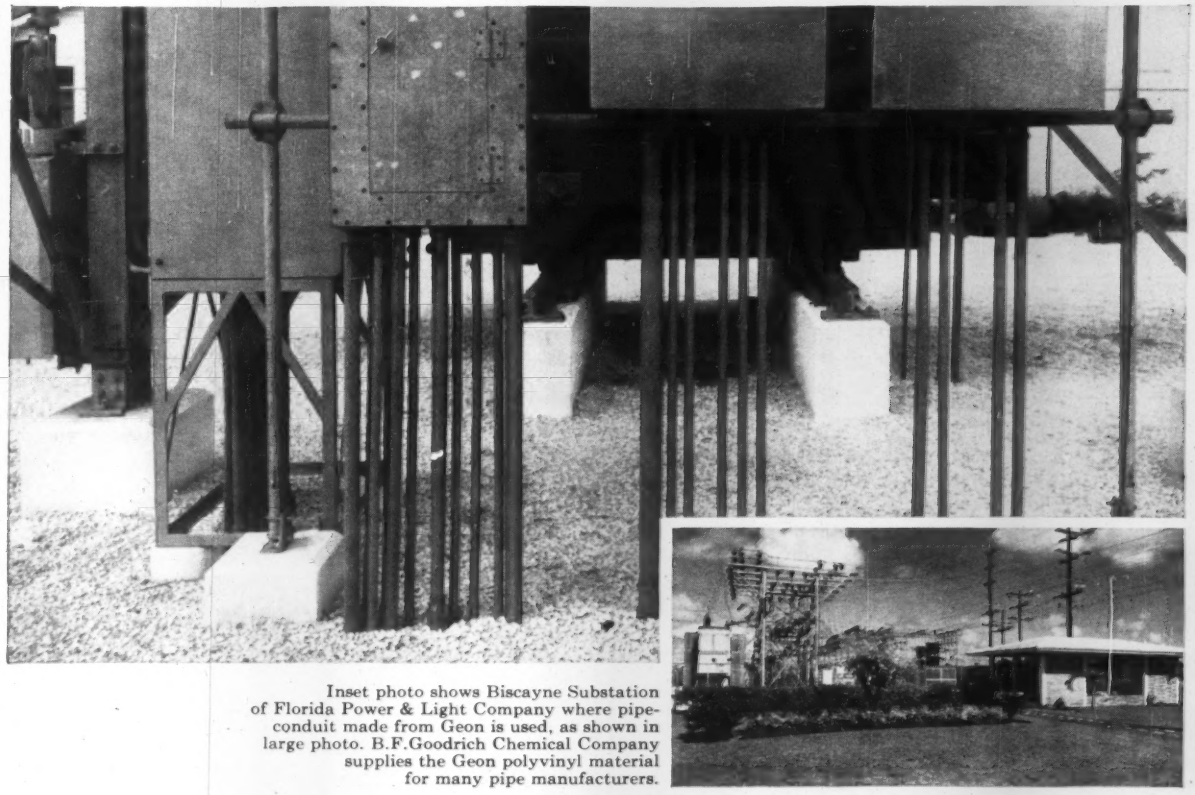
# B.F.Goodrich Chemical *raw materials*



Inset photo shows Biscayne Substation of Florida Power & Light Company where pipe-conduit made from Geon is used, as shown in large photo. B.F.Goodrich Chemical Company supplies the Geon polyvinyl material for many pipe manufacturers.

*At 125 substations . . .*

## FP&L plans for future . . . uses conduit of Geon

Florida's rapidly expanding economy has called for fast, sure growth on the part of Florida Power & Light Company. At 125 distribution substations located throughout the state, FP&L has installed conduit made of Geon rigid vinyl—as much as 3,000 feet at some locations.

Conduit of Geon rigid vinyl is lightweight and economical to install—and promises satisfactory service far longer than ordinary conduit because it is unaffected by most causes of corrosion. Internal and external surfaces stay smooth—like new through the years.

Geon resists the corrosive effects of salt water, gases, chemicals, and acid or alkaline soils. It also resists sunlight, fungi, bacteria, moisture, heat and cold. It offers high tensile or impact strength and is not affected by galvanic corrosion.

Engineers are finding new and cost-saving uses for pipe and conduit made of Geon in many applications, both above ground and underground. For information, write Dept. GG-6, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Geon VINYLS

**B.F.Goodrich Chemical Company**
**a division of The B.F.Goodrich Company**

**B.F.Goodrich** GEON vinyls • HYCAR rubber and latex • GOOD-RITE chemicals and plasticizers

# NEW HOTEL ROBERT MEYER, JACKSONVILLE, FLA.

*Architect:* William B. Tabler, New York. *General Contractor:* Daniel Construction Co., Jacksonville. *Consulting Engineer:* Slocum & Fuller, New York. *Mechanical Contractor:* Henley & Beckwith, Jacksonville. *Interior Decoration:* Walter M. Ballard Corp., New York.

# CUSTOM-BUILT FOR CONVENTION CONVENIENCE

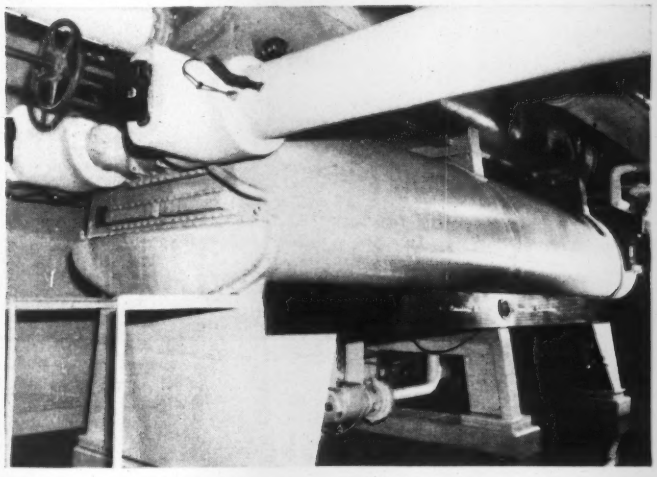
## Keeps conventioneers cool and comfortable with GAS and CARRIER absorption refrigeration

The ultramodern new Robert Meyer, Florida's newest and largest commercial-convention hotel, leaves nothing undone for the maximum comfort of its guests. For year 'round climate control they chose one of the most efficient, up-to-date systems available . . . Carrier Weathermaster* air conditioning and absorption refrigeration energized by steam from a gas-fired boiler.

The Carrier absorption system is the essence of simplicity and economy. It quietly and efficiently converts steam or hot water from a gas-fired boiler into chilled water for air conditioning. Thus, boiler capacity is put to use on a year 'round basis . . . cooling in summer, heating in winter. And thrifty gas keeps fuel costs low.

For highest efficiency in year 'round air conditioning, specify Gas and Carrier Absorption Refrigeration. Performance data and cost details are yours for the asking. Call your local Gas Company, or write Carrier Air Conditioning Co., Syracuse 1, N. Y. *American Gas Association.*

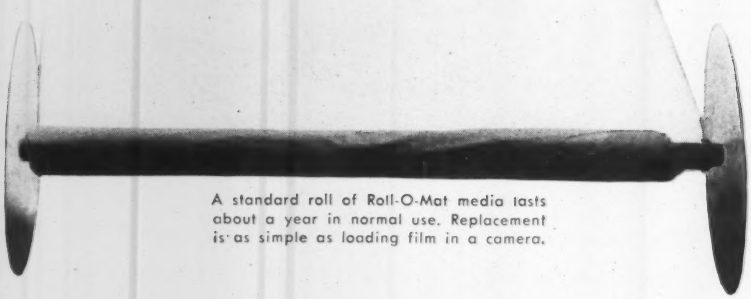
**FOR HEATING & COOLING GAS IS GOOD BUSINESS!**



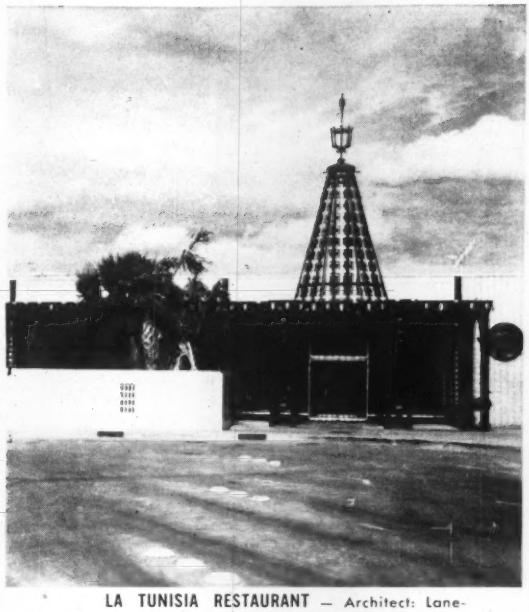
*This 750-ton capacity Carrier absorption unit, one of the largest of its type in the South, supplies chilled water to carry the full load for year 'round air conditioning at the Hotel Robert Meyer.*

**BRANIFF AIRWAYS BUILDING** — Architect: Lane-Gamble; Mechanical Consulting Engineer: Wm. K. Hall; Mechanical Contractor: Sam P. Wallace & Co.

# *Clean air by the ROLL . . . . in*



A standard roll of Roll-O-Mat media lasts about a year in normal use. Replacement is as simple as loading film in a camera.



**LA TUNISIA RESTAURANT** — Architect: Lane-Gamble; Mechanical Consulting Engineer: Wm. K. Hall; Mechanical Contractor: Farwell Co.

**EXCHANGE BANK BUILDING** — Architect: Lane-Gamble; Mechanical Consulting Engineer: Blum & Guerrero; Mechanical Contractor: Sam P. Wallace & Co.

# *Dallas' Exchange Park*

## AAF Roll-O-Matic filters provide 'Better Air' for Park buildings

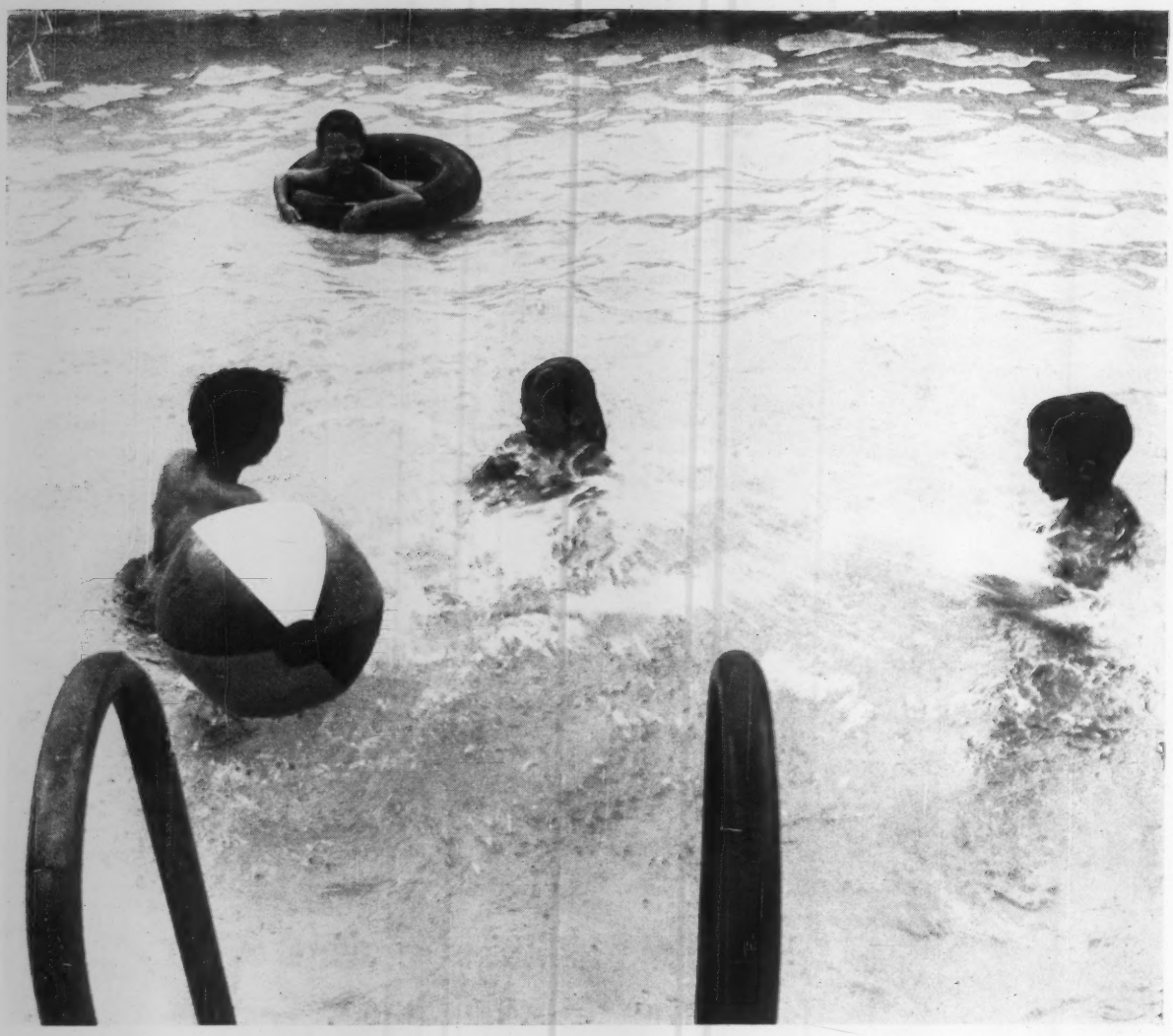
These three impressive Exchange Park structures are assured of perpetually clean air with an absolute minimum of filter maintenance. Reason: AAF Roll-O-Matic air filters.

The amazing Roll-O-Matic cleans itself automatically while it cleans the air. Maintenance amounts to nothing more than once-a-year replacement of Roll-O-Mat media—an operation as simple as changing the film in a camera!

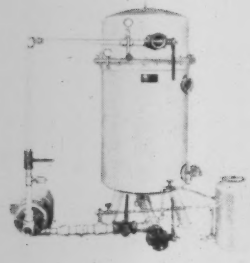
For complete product information on the Roll-O-Matic, call your local AAF representative or write direct for Bulletin 248. Address: Mr. Robert Moore, American Air Filter Company, Inc., 373 Central Avenue, Louisville, Kentucky.

AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS



# here's why leading engineers specify Bruner pool filters:



**exclusive features:** Bruner's plastic disc core septum, "Air Bump" and "Air-Vac" systems add to the life of the filter, increase filter run, and speed cleaning operations. All three are Bruner exclusives.

**proven quality:** Bruner pool filters have been field tested for years under all water conditions, are backed by Bruner's reputation for dependability.

**custom-tailored:** In addition to providing filters out of stock, Bruner can tailor filtering systems to fit your exact needs. For more information contact your nearest Bruner Sales Office or the Bruner Industrial Sales Department.

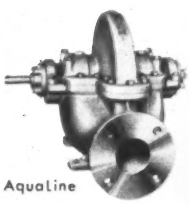
BRUNER
WATER SOFTENERS & FILTERS

**BRUNER Corporation**
4767 North 32nd Street, Milwaukee 9, Wisconsin
DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

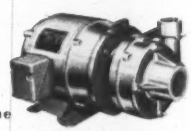
# INSTALL THESE BETTER PUMPS WITH DOWN-TO-EARTH PRICE TAGS

PEERLESS PUMPS

## PEERLESS END SUCTION AND SIDE SUCTION AIR CONDITIONING PUMPS COST LESS—LAST LONGER



Aqualine



Fluidyne

**PEERLESS AQUALINE® Pumps** are available in sizes to 8-inches. Capacities to 2600 gpm, heads to 280 feet. Temperatures to 250°F. Horizontal split case design allows quick inspection without disturbing piping.

**PEERLESS FLUIDYNE® Pumps** are compact end-suction design. Redi-Packed in 22 sizes from 1 x 2 x 6 to 2½ x 3 x 10, for immediate shipment. Heads to 230 feet, capacities to 300 gpm, motors from 1 to 15 hp.

*Priced right* – That's the first Peerless economic factor you find in every Peerless Aqua-Line and Fluidyne water handling pump.

*Quality Engineered* – It is a factor that shows up on the higher performance ratings these pumps give you. And their remarkably trouble-free operation records deliver a full measure of customer satisfaction that's hard to beat.

*Versatile*–Outdoors or indoors, Peerless AquaLine and Fluidyne pumps meet the needs of hundreds of water handling services. Chilled water, booster service, in-plant, and cooling systems of all types are but a few of the many applications for which these pumps are ideally suited.

*Immediate Availability*–Close-by regional warehouses, plus two big factories place these pumps at your job in shortest time possible.

Get the full story now on Peerless AquaLine and Fluidyne pumps. Send for more information today.

**ATTENTION DEALERS:** A limited number of Peerless AquaLine and Fluidyne pump dealerships are available. Please write for complete information.

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*Putting Ideas to Work*

fmc FOOD MACHINERY AND CHEMICAL CORPORATION

**Peerless Pump**

HYDRODYNAMICS DIVISION

*Offices:*

New York; Detroit; Cleveland; Chicago; Indianapolis; St. Louis; San Francisco; Atlanta; Plainview; Lubbock; Phoenix; Albuquerque; Los Angeles; Fresno.

*Distributors in principal cities.* Consult your telephone directory.

**Peerless Pump, Hydrodynamics Division, Food Machinery and Chemical Corporation**
2005 Northwestern Avenue, Indianapolis 8, Indiana

**Gentlemen:** Please send me immediately:

- ☐ Bulletin B-2319 on Peerless Fluidyne Pumps.
- ☐ Bulletin B-2100 on Peerless Aqualine Pumps.
- ☐ Name and address of nearest Peerless Dealer.

Name_____

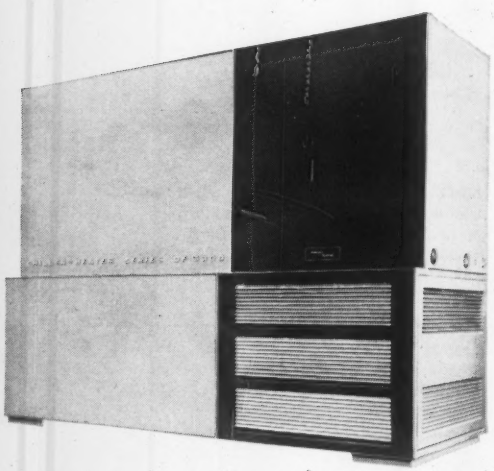
Address_____

City_____

State_____

# A MAJOR BREAKTHROUGH IN COOLING & HEATING

## ARKLA'S NEW 25-TON GAS CHILLER-HEATER

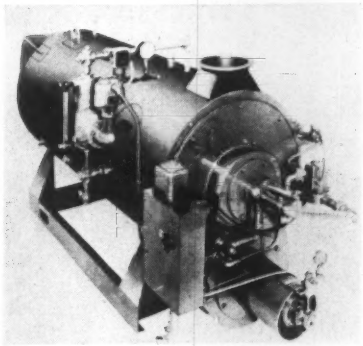


Here it is—the revolutionary new Arkla absorption unit that heats and cools without a steam producing boiler or converter. Gas-fired burners in the generator section energize the system for absorption cooling, or for heating. It's the perfect system for modern year 'round gas air conditioning.

INSTANTLY HEATS AND COOLS AUTOMATICALLY ■ HEATS WATER WITHOUT A BOILER ■ COOLS WATER WITHOUT A COMPRESSOR ■ REQUIRES NO LUBRICATION ■ SEALED FOR LIFE, REQUIRING MINIMUM MAINTENANCE ■ MAINTAINS SAME CAPACITY FOR THE LIFE OF THE UNIT ■ HAS NO MOVING PARTS IN THE HEATING AND COOLING CYCLE ■ FIRST MEDIUM OR LARGE TONNAGE AIR CONDITIONER THAT HEATS. Truly revolutionary . . . investigate for your next building project the new Arkla DF-3000 Gas-fired All Year® Chiller-Heater. For details contact your local Gas Company. Or write Arkla Air Conditioning Corporation, 812 Main Street, Little Rock, Arkansas.

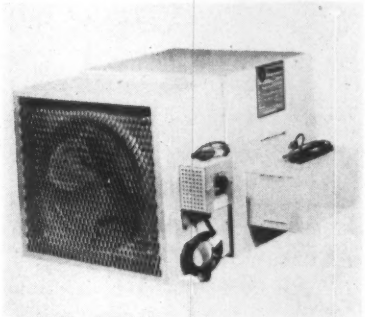
# EQUIPMENT DEVELOPMENTS

*Information on capacities, dimensions, applications, and special features in each item is presented in accordance with material furnished by the manufacturers, who may be contacted directly for more details. For reviews of Recent Trade Literature see page 179*



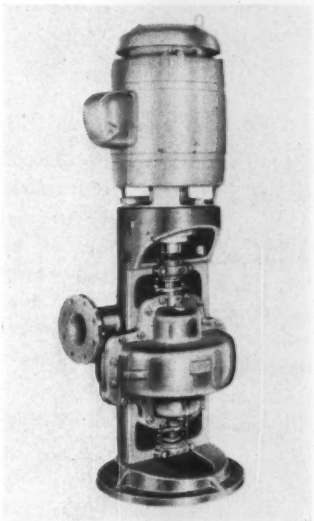
**Packaged Boilers . . .**

. . .for industries requiring process steam. Steel units available in six models ranging from 16 to 60 bhp. Minimum 80 percent efficiency is guaranteed by firm. Standard voltages from 110 to 550 v; steam capacities per hr from 518 to 2070 lb; Btu output ranges from 502,500 to 2,010,000 per hr. — *Crane Co., Cyclotherm Div., 157 E. First St., Oswego, N.Y.*



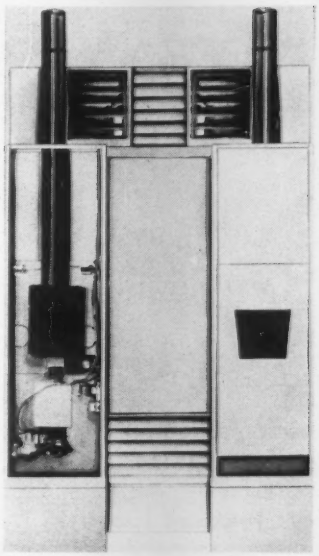
**Air Cleaners . . .**

. . .for portable use. Suitable for hotel and motel meeting rooms, restaurants, offices, and similar applications. Cleans air in a 9000 cu ft room with a complete air change every 10 minutes. Removes smoke, dirt, dust, pollen, and germs. Multiple units may be used when area is larger than 9000 cu ft. — *Trion, Inc., McKees Rocks, Pa.*



**Centrifugal Pumps . . .**

. . .two stage split case units for cooling towers, circulation and boiler feed, and other applications. Bearing housing supports, suction and discharge flanges integral with vertical base section of case allowing removal of rotating element without disturbing suction or discharge connections. Capacities range to 1400 gpm with heads to 425 ft. — *Aurora Pump Div., New York Air Brake Co., Aurora, Ill.*



**Heater, Ventilator . . .**

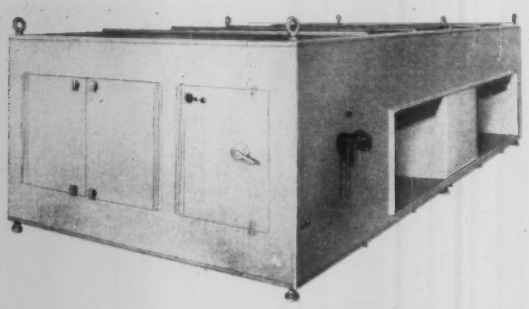
. . .gas-fired, forced-air installation for schoolroom application. Air distribution is through bookshelf sections around outside perimeter of classroom under windows. Available in capacities of 80,000 to 100,000 Btu per hr. — *Norman Products Co., 1150 Chesapeake Ave., Columbus 12, O.*

**Titanium Bellows Joints . . .**

. . .for chemical processing application. Extreme resistance to corrosion by wet chlorine gas, chlorine solutions, chlorinated organic and inorganic chloride solutions. — *Tube Turns Div., Chemetron Corp., 224 E. Broadway, Louisville 1, Ky.*

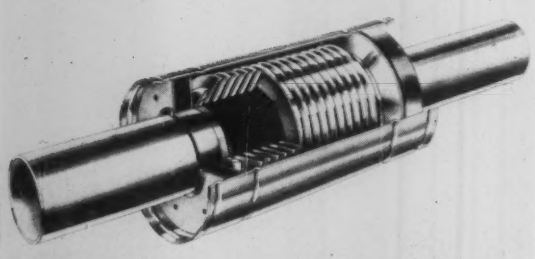
## EQUIPMENT DEVELOPMENTS

*Continued*



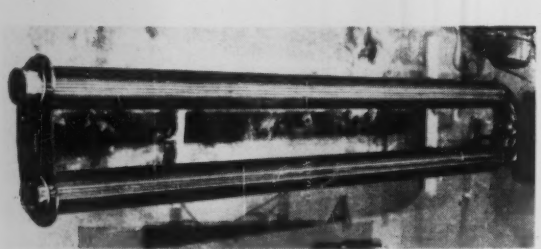
### Make-Up Air Heater . . .

. . .direct-fired unit, completely packaged, requires no ductwork, and is independent of existing heating system. Available in 26 standard sizes ranging from 8000 to 150,000 cfm. Full modulating turn-down ratio 25 to 1. Form 552-1-60 sent on request. — *National Heater Co., Inc., St. Paul 8, Minn.*



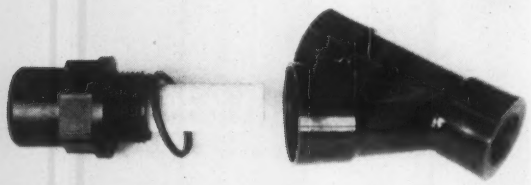
### Expansion Joints . . .

. . .for hot water and steam heating installations on straight baseboard runs of 25 ft or more for water temperatures ranging from 100 to 250 F. Large bronze bellows with copper tubing electronically welded at each end for sweat connections. Unit water-tight. Recommended maximum pressures: hot water, 45 psi; steam, 15 psi. — *Modine Mfg. Co., 1500 DeKoven Ave., Racine, Wis.*



### Immersion Heaters . . .

. . .with perforated fintube design to permit higher rates of heat transfer and to accelerate thermal currents within tank. Two sizes, 8 and 10 in. diameter tube. Fired with either gas or oil. 8 in. unit's capacity is 750,000 Btu per hr, and 10 in. unit has a 1,250,000 Btu per hr capacity. Bulletin 400 sent on request. — *Brown Fintube Co., 300 Huron St., Elyria, O.*

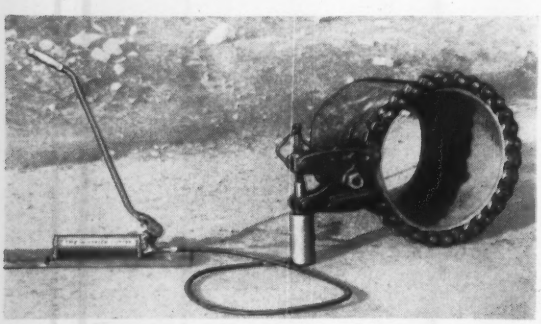


### Pipe Line Strainers . . .

. . .polypropylene units for applications involving solvents, greases, oils, and a majority of common acids at temperatures up to 185 F. Strainer element can be easily removed for cleaning or replacement. Available in sizes ½ through 2 in. with molded thread or socket weld ends. — *Vanton Pump & Equipment Corp., Hillside, N.J.*

### Portable Heater . . .

. . .weighs 80 lb and operates on a 115 v a-c outlet, burning kerosene or No. 1 or 2 fuel oil. Thermostatically controlled unit has 125,000 Btu per hr capacity. Other models range from 75,000 to 400,000 Btu per hr. Literature sent on request. — *Master Vibrator Co., 365 Stanley Ave., Dayton 1, O.*

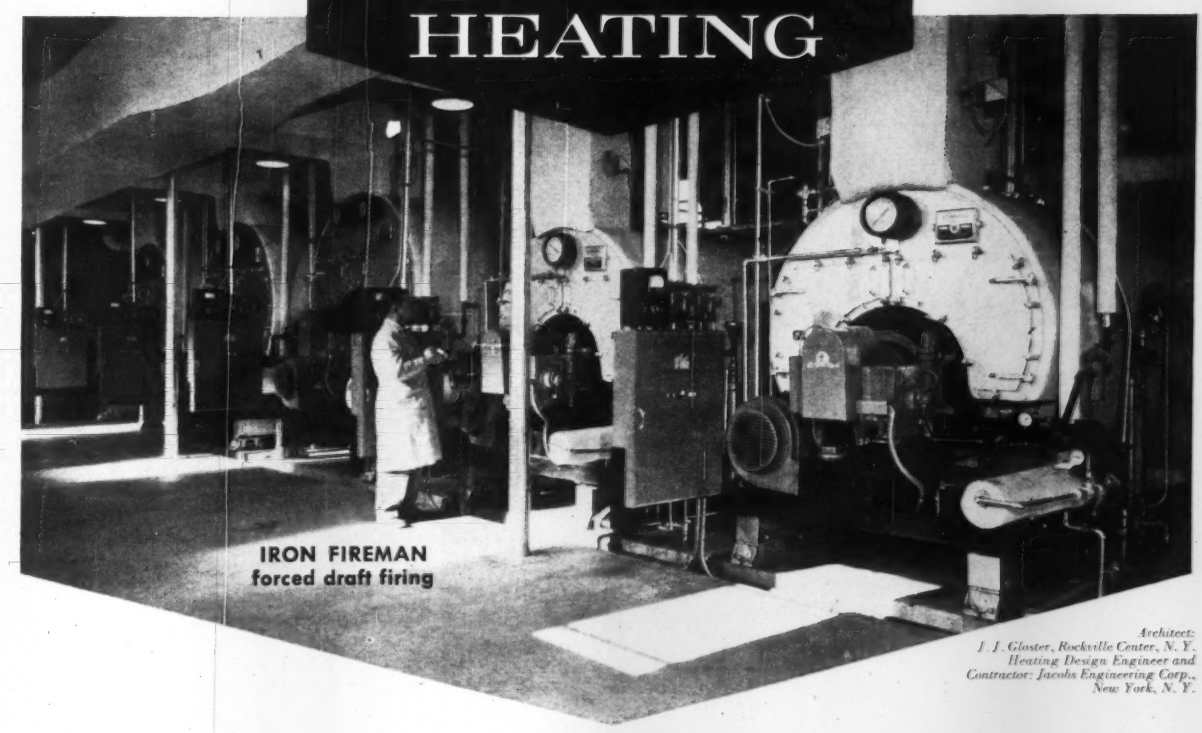


### Hydraulic Pipe Cutter . . .

. . .for use on 10 through 20 in. diameter cast iron pipe. Unit uses firm's "squeeze and pop" principle. No accessory equipment needed. Two men set up unit; one man cuts pipe. — *Wheeler Mfg. Corp., Ashtabula, O.*

The new world of

# HEATING




*Architect: J. J. Gloster, Rockville Center, N. Y. Heating Design Engineer and Contractor: Jacobs Engineering Corp., New York, N. Y.*

## "Today's package units remove uncertainty"

*says Mr. Fred Reidel, Chief Engineer, Mid-Island Hospital, Bethpage, L. I.*

"The old-fashioned way of installing boilers," says Mr. Reidel, "required that we get separate estimates for burners, steel front plate, brick combustion chamber, oil heating equipment and wiring. Everything was assembled at the site. Now the finished unit is simply lowered into place and bolted down."

A single contract not only keeps your installation costs under control, but greatly reduces these costs as well. It also narrows responsibility for the proper installation and functioning of the equipment.

**Easy to size and specify.** After determining the required load and deciding on the fuel (gas, oil or dual-fuel combination), it is only necessary to refer to a chart to find the correct size of unit, or units, for your job.

**Multiple units have many advantages.** You can have a tailor-made plant with low initial cost. A stand-by unit protects you against emergencies or peak loads. You can split your plant between high and low pressure boilers to meet special needs, or between steam and hot water units. Capacities range from 10 to 650 boiler horsepower.

*For full information, please mail the coupon below*

# IRON FIREMAN

HEATING AND AIR CONDITIONING
AIRCRAFT COMPONENTS AND EQUIPMENT
MISSILE AND AIRCRAFT GYROSCOPES
ELECTRONIC EQUIPMENT
CONTROL INSTRUMENTS

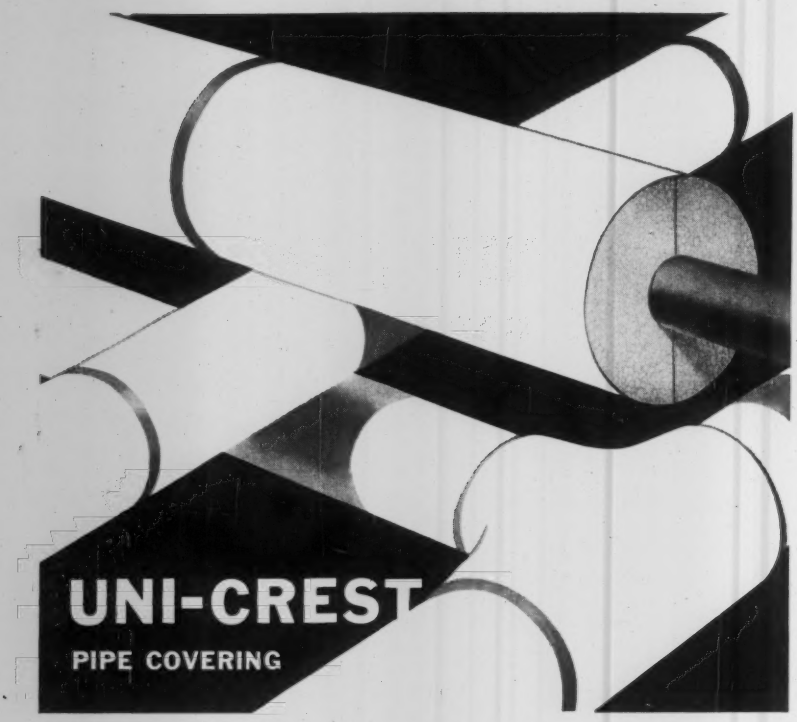
Iron Fireman Mfg. Co., 5103 West 106th St., Cleveland 11, Ohio. (In Canada, 80 Ward St., Toronto)
Please send complete technical descriptions and specifications for oil, gas or oil-gas combination firing.

Name_____

Company_____

Address_____

City_____ State or Prov._____




a new, economical, low temperature insulation

Uni-Crest expanded polystyrene pipe covering is an excellent low temperature insulating material, and is inexpensive to install and maintain.

Its low thermal conductivity (K factor) plus its high resistance to water and water vapor — are some of its prime qualities. It will not rot, mildew, or support fungus growth.

Extremely lightweight, with a smooth, tough white surface, Uni-Crest is non-dusting, non-flaking, and easily cut and handled on the job.

Uni-Crest and self-extinguishing Uni-Crest are available in a wide variety of sizes and shapes. Both types are also available with or without a paper and foil laminate jacket.

*For the address of the office nearest you, plus additional information and an actual sample, please write to the address below.*

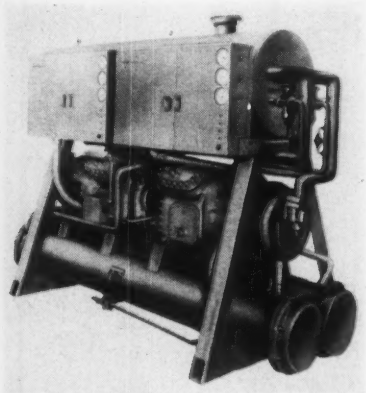
UNI-CREST DIVISION UNITED CORK COMPANIES
Since 1907

UNITED'S UNI-CREST EXPANDED POLYSTYRENE

1 Central Avenue, Kearny, New Jersey

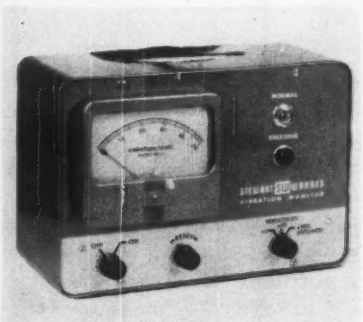
BRANCH OFFICES OR APPROVED DISTRIBUTORS IN ALL KEY CITIES


## EQUIPMENT DEVELOPMENTS
*Continued*



### Water Chillers . . .

. . . for industrial and commercial air conditioning installations. Eight sizes of units, from 20 to 100 tons. Compressor motors protected by overtemperature control circuit. Larger units (60, 80, and 100 tons) have twin compressors. Each unit has wired control center including starters and safety operating controls. — *Westinghouse Electric Corp., Air Conditioning Div., Staunton, Va.*



### Vibration Control . . .

. . . for protecting equipment and processes against damage from excessive vibration. Sensitive to vibrations as small as two millionths of an in. amplitude. Units flash signal or stop machine if pre-set limit of vibration is exceeded. With an accessory plug-in attachment, unit becomes a portable balancer to be used in correcting the unbalancing condition. — *Stewart-Warner Corp., 1826 Diversey Parkway, Chicago 14.*

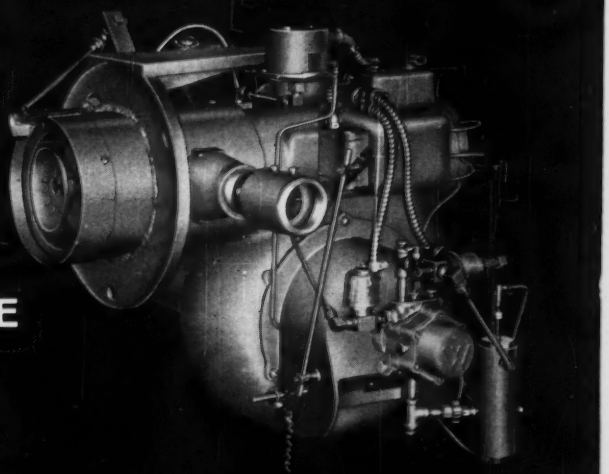
# *new RAY Forced Draft Burners—*

**CUT**
**CONSTRUCTION COSTS**

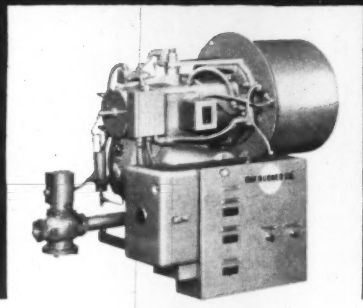
**CUT**
**FUEL COSTS**

**CUT**
**ERRATIC PERFORMANCE**

**CUT DOWN-TIME**



Ray Forced Draft Burner



Completely packaged Ray Forced Draft Burner

New Ray Forced Draft burners are available two ways to meet your needs and budget. Burner alone, or as a completely packaged combustion unit. Both offer all these exclusive performance features:

**FAST INSTALLATION**—Completely contained wiring is expertly done at the Ray factory. Field connecting is limited to a minimum with only simple external fuel and electrical connections to be made.

**AMAZING FUEL ECONOMY**—Ray is the only burner offering full modulation for both gas and oil. Ends step-firing and starting with a puff. With full modulation, burner closely follows load demand, maintaining steam or hot water capacity at all times, with resultant efficiency and economy.

**SMOOTH PERFORMANCE**—Smooth low to high fire transition is supplied by the Ray MODUFIRE System, along with guaranteed low-fire start. Burner gradually increases from low flame to high, then instantly drops back to low when boiler demands are met.

**NO SMOKE, NO STACK**—Clean burning from the start. Forced Draft design eliminates the need for an unsightly stack.

**FIT ANY BOILER TYPE**—These fully automatic units are available in three sizes to fit any type boiler and have maximum capacities ranging from 7 to 30 gallons per hour.

**BURNS HEAVY OIL**—Models of this burner are available to burn gas and all grades of fuel oil, including #5 heavy oil. No refractory is required for combustion when stainless steel flame funnel is specified for straight oil firing burner.

*Local factory-trained service in principal cities*

RAY SINCE 1872

**BURNER COMPANY**

1301 San Jose Avenue, San Francisco, California
629 Grove Street, Jersey City, New Jersey

# FUEL COSTS DROP 40% with DRAVO COUNTERFLO HEATERS!

**The problem . . .** after plant expansion, 48,600 square feet of widely varying construction had to be heated efficiently. Some roofs were uninsulated, and large truck doors let in frigid air during winter. The old coal-fired steam heating plant was inadequate; a new heating system was needed. Management compared costs of various heating methods, including probable maintenance expense, and arrived at the following conclusion:

**The solution . . .** Dravo forced air space heaters. Floor mounted, thermostat controlled Dravo *Counterflo* heaters met requirements for comfort heating. Truck entries were protected by discharge nozzles aimed to provide a protective blanket of warm air. Each area was maintained at the desired temperature level. Drafts were eliminated, and heat loss to roof areas held to a minimum. Heating costs were lowered by 40%, a saving of *$.06 per square foot.*

**Bonus benefits . . .** include very low maintenance costs. A combination fireman - watchman was no longer needed—additional savings. The elimination of the boiler plant added 600 square feet of usable floor space. Use of Dravo Heaters permitted the installation of an automatic fire and burglar protection system, reducing insurance costs. Total savings to this company as a direct result of the installation of Dravo Heaters—$5,800 a year.

**More information . . .** on how Dravo *Counterflo* Heaters can help you lower heating costs. Send the coupon for details on the case history outlined above and full information on economical, high efficiency Dravo Space Heaters.

**DRAVO**

CORPORATION

Department H-14, Room M-214
Pittsburgh 25, Pa.

Send free bulletins on warm air space heating and the facts on the company mentioned above.

Name _____

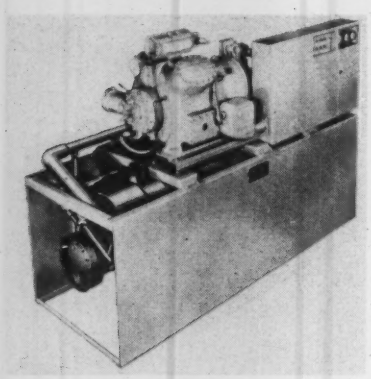
Company _____

Address _____

City _____ Zone ____ State ____

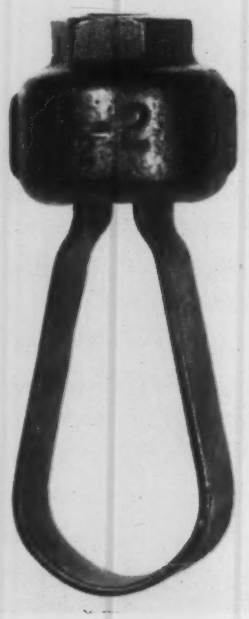

## EQUIPMENT DEVELOPMENTS

*Continued*



### Packaged Water Chillers . .

. . .for air conditioning or industrial cooling applications. Available in 11 models for net rate capacities up to 67.1 tons, depending upon condenser water and desired leaving chilled water temperatures. Requires minimum of field water piping and electrical connections. — *American-Standard Industrial Div., Detroit 32.*



### Tube Hangers . . .

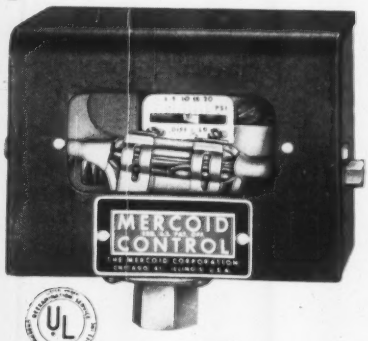
. . .for copper tube sizes from $\frac{3}{8}$ through 6 in. Adjustable ring, hinge, and clevis type hangers are extra heavy copper plated for permanent corrosion resistance. Base metal is steel. — *The Grabler Mfg. Co., 6565 Broadway, Cleveland 5.*


Small, Lightweight

# MERCOID PRESSURE CONTROL for Instrument Air

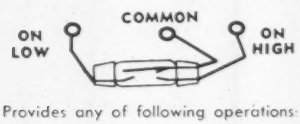
*Exclusive Features*

EXTERNAL ADJUSTMENT
VISIBLE CALIBRATED DIAL
VISIBLE SWITCH POSITION
FOR PANEL OR PIPE MOUNTING
SEALED MERCURY CONTACT




TYPE AP-153

| ADJUSTABLE OPERATING RANGE | SWITCH DIFFERENTIAL With Pointer Set At | |
|---|---|---|
| | LOW | HIGH |
| 1 to 20 psig. | 0.3 | 0.5 |
| 1 to 30 psig. | 0.4 | 0.75 |




Provides any of following operations:

1. *Single Pole—Cut-in high (close on rise)*
2. *Single Pole—Cut-in low (open on rise)*
3. *Single Pole—Double Throw*

OTHER TYPES AVAILABLE

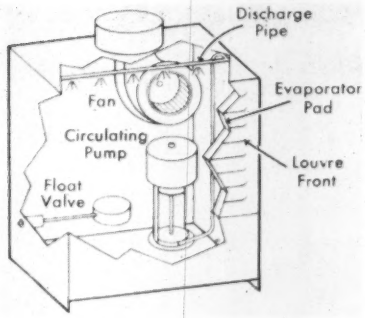
**CASE: NEMA 1—Heavy gauge steel, cadmium plated. Steel cover (with glass front).**

WRITE FOR BULLETIN 02

THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

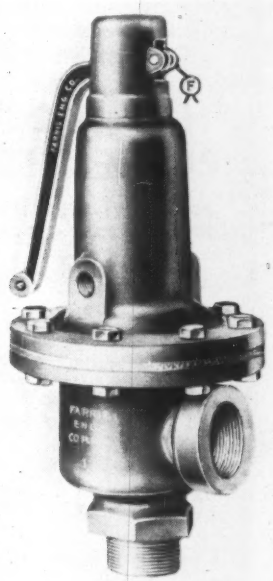
## EQUIPMENT DEVELOPMENTS

*Continued*



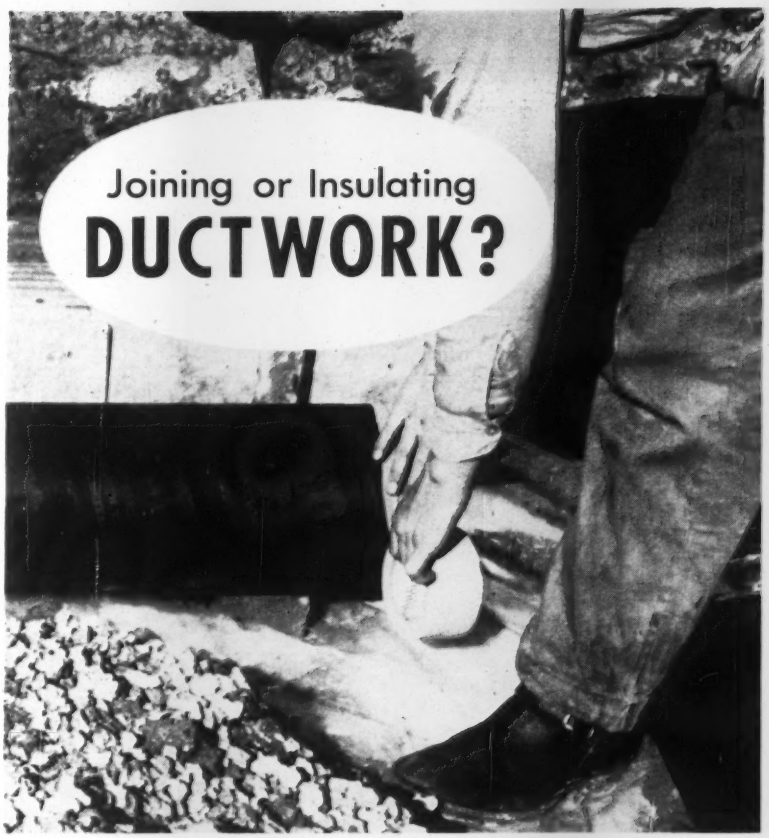

**Humidifier . . .**

. . . for application with hot water, steam, gravity warm air, and large forced air systems. Pump circulates water controlled through automatic float valve over special design evaporator pad. High volume fan discharges air throughout building. Unit includes a humidistat. — *H. G. Stocker & Son, Osceola, Wis.*



**Diaphragm Relief Valve . .**

. . . for chemical corrosive service. Provides vapor tight seal to prevent leakage and eliminate waste. Type 316 stainless steel, bronze, and hastelloy "C" for valve body; neoprene, molded kel-F, or stainless steel for diaphragm and disc. Sizes: ½, ¾, 1, 1¼, 1½, and 2 in. May be mounted in horizontal or vertical position. — *Farris Engineering Corp., Palisades Park, N.J.*


Do it quicker, neater . . . with

**Shuford's SHURTAPE® MP-26**

Metallized Paper Insulation Tape

To save yourself time and money on the job, use Shuford's SHURTAPE MP-26 for holding insulation to ductwork and for sealing joints of metal or fibre duct.

This silver-colored tape is especially designed for use in heating and air conditioning installations. It's inexpensive, easily applied, and you get an inconspicuous, positive seal with a neat finished appearance. Faster than staples—looks better too!

SHURTAPE MP-26 is treated with flame-inhibiting chemicals to retard inflammability. It has excellent resistance to water and abrasion, resists solvents and oils, and its moisture vapor transfer rate is virtually nil.

*For complete information, write*

CLOTHES LINES • TWINES
PRESSURE-SENSITIVE PAPER TAPES
SASH CORDS • WEATHER STRIPPING
COTTON & RAYON YARNS • EXTRUDED PLASTICS

Shuford Mills, INC SINCE 1880
HICKORY, N. C.

5077

Safety and Relief Valves with a STRAIGHT "A" AVERAGE

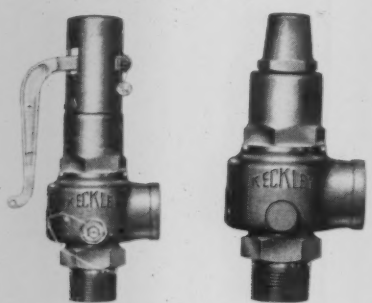
APPROVAL (ASME)

ACCEPTANCE

AVAILABILITY

**Keckley Pop Safety and Relief Valves meet A.S.M.E. requirements and are suitable for steam, liquid, air and gas service. Sizes from ½" to 2½". Bronze bodies, for pressures to 300 lbs. at temperatures to 425° F.**

**By combining 46 years of experience in the valve business, the latest machinery and methods, and a modern plant, Keckley assures you of quality products, with a good name, *always ready for shipment*. And you will be pleased with the cooperative engineering service you receive from Keckley in meeting your requirements.**



No. 40 Safety Valve  No. 42 Relief Valve

***Write for Bulletin No. 660***

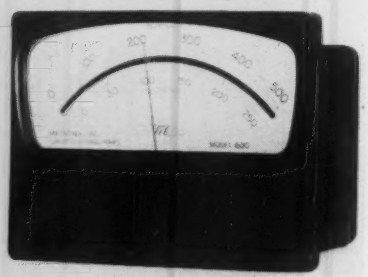
O. C. KECKLEY COMPANY
General Offices and Factory
3400 Cleveland Street
Skokie, Illinois

KECKLEY

Pressure Regulators • Temperature Regulators • Float Valves • Strainers • Solenoid Valves • Reducing Valves • Pop Safety Valves • Relief Valves


## EQUIPMENT DEVELOPMENTS

*Continued*

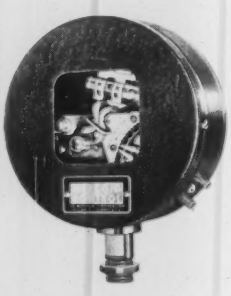


### Temperature Indicator . . .

. . . for use with thermocouples as long as 10,000 ft. Panel mounting d-c electronic voltmeter with input resistance of 100,000 ohms. Available in eight temperature ranges and five voltage ranges. Unit operates on 115 v. 60 cycle, single phase. Accuracy is ±2 percent of full scale deflection. — *Metronix, Inc., Chesterland, O.*

### Water Chillers . . .

. . . gas powered packaged units for commercial application. Capacity 100 tons. Equipped with automatic controls, accessories, and safety devices. — *Waukesha Motor Co., Waukesha, Wis.*



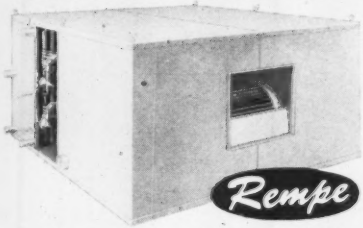
### Pressure Control . . .

. . . with an operating range of 500 to 5000 psi. Available in three minimum operating differentials of 450, 200, and 150 psi. Unit has welded steel Bourdon tube power element, external adjustment, visible dial, and a sealed mercury contact with visible on/off circuit position. Special sealing nut assures leak-proof connection. — *The Mercoid Corp., 4201 Belmont Ave., Chicago 41.*


REMPE

Heat Transfer Equipment

PACKAGED UNITS FOR AIR HANDLING




**Heating • Cooling • Dehumidifying**

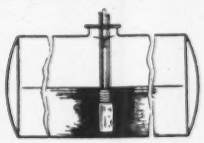
Unit illustrated is 15-ton capacity with coil for chilling air to 40° F. and a two row steam reheat coil for tempering air to 70° before leaving unit. Air filters and rack included.

Blower handles 4200 CFM air with 1½ HP motor. Two 7½ ton coil sections may be used together or separately. Steel hot galvanized cooling coils are available for Ammonia . . . Copper tube for Freon or chilled water.

"HOT SPOT" PREHEATER

*FOR HEAVY OILS AND LIQUIDS IN BULK STORAGE*

Preheats fuel oils and other liquids to proper flow temperature before entering the suction line.



***Heats with Steam or Hot Water***

The Rempe "Hot-Spot" does an efficient preheating job . . . releases more BTU'S from fuel oils. Special flow accumulator causes liquids to pass over heated coils. Takes the load off the suction pump.

All steel shell and coil assembly—14" or 16" shell diameters—Connections furnished correct length for any tank diam.

*Engineering Data Book*

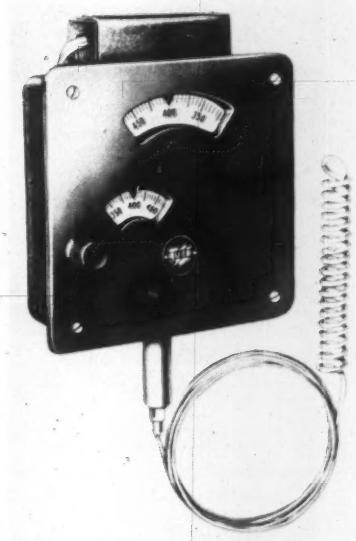
Pipe Coil and Fin Coil Designs. Heat Transfer Coefficients. Get a copy for your library.

REMPE COMPANY

342 N. Sacramento Blvd. • Chicago 12, Ill.

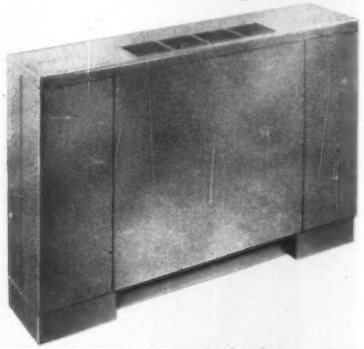
## EQUIPMENT DEVELOPMENTS

*Continued*



### Temperature Control . . .

. . . indicating unit covering range of —150 to 650 F. Replacement of thermal assembly in field does not disturb calibrating mechanism. Two separate switches permit switch action above or below index set point and control of up to four independent circuits. Electrical rating 15 amp. 115/230 v a-c; other ratings available. — *United Electric Controls Co., 79 School St., Watertown 72, Mass.*

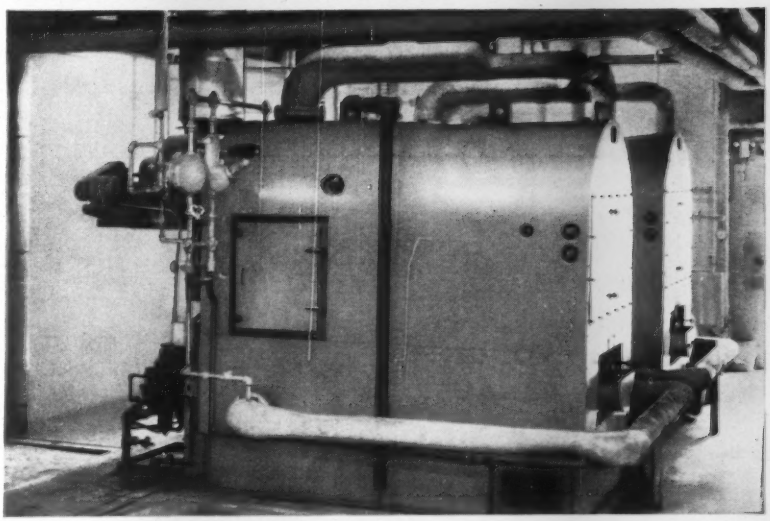


### Fan-Coil Units . . .

. . . for remote individual room application with central hydronic cooling and heating systems. Four models, each with five sizes from 200 to 600 cfm. Floor or ceiling mounted, 8½ in. wide model has easily accessible components. — *Bohn Aluminum & Brass Corp., Danville Div., Danville, Ill.*


FOR DEPENDABLE HEAT . . .

VITRO LABS DEPEND ON IBW COMPAKS



Fast heating . . . low operating cost . . . water tube boiler efficiency and dependability —these are key features of the International COMPAK Generators at the Silver Spring, Md. plant of Vitro Laboratories, a division of Vitro Corporation of America.

These fully automatic package units respond instantly to changing load demands—a big plus advantage of International water tube design featuring rapid and directed internal water circulation.

Learn the true value of International boilers, where . . . "a little more buys a lot more" in dependability, economy and long life service.

*GET THE FULL DETAILS FROM YOUR INTERNATIONAL DISTRICT REPRESENTATIVE OR WRITE FOR BULLETINS 600 AND 1400 TODAY*

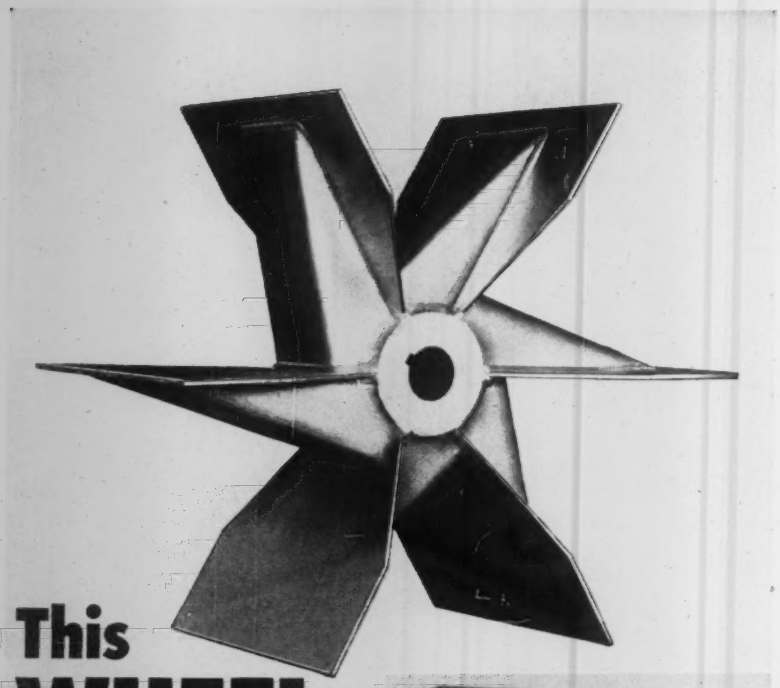
**THE INTERNATIONAL BOILER WORKS CO.**

810 SPRUCE STREET EAST STROUDSBURG, PA.

BOILER BUILDERS SINCE 1886

Steel Firebox Heating & Power Boilers • Low & High Pressure Water Tube Package Boilers • International-LaMont Forced Recirculation Generators • ASME Code Pressure Vessels & Welded Products

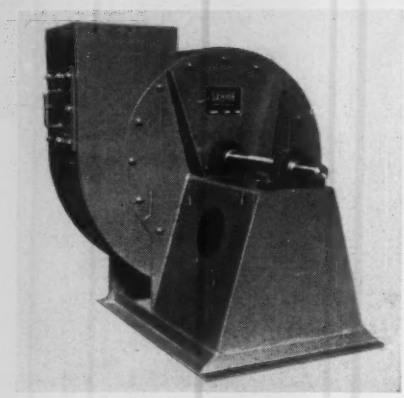
Manufactured and sold in Canada under agreement with CANADIAN VICKERS LTD. Montreal, P. Q.



# This WHEEL

## MAKES LEHIGH I. E. INDUSTRIAL FANS IDEAL FOR TOUGH INDUSTRIAL EXHAUST APPLICATIONS

**Handles dust-laden air and gases, paper shavings and the like without clogging**



Lehigh Industrial I.E. Fans . . . featuring heavy duty, unique channel construction, all-welded mild steel wheels of the long shaving design . . . solve difficult exhaust problems because of their non-clogging characteristics. They incorporate a universal housing, which permits rotation and discharge to be modified to facilitate variable field conditions.

**A complete range of sizes** is available in both 70° to 250°F and 251° to 600°F construction. All standard drive arrangements are available and will be furnished according to your specifications.

**Rugged, air-tight construction:** the fan housing is welded on the inside with a continuous fillet weld. This provides gas-and air-tight housing with joints of maximum strength.

**Standard, self-aligning ball-bearing pillow blocks** . . . grease lubricated . . . are featured on all Lehigh Industrial I.E. Fans.

**Optional accessories** include an inspection door, inlet and outlet flange, heavy duty housing construction, and drain plug.

**Get detailed information** on how Lehigh I.E. Industrial Fans can solve your industrial exhaust problems with dependable non-clogging performance. Your Lehigh Representative will be happy to supply you with full details. Or, if you choose, write directly to us for Bulletin L-5:

2172
LF-2

**LEHIGH FAN & BLOWER DIVISION**
**FULLER COMPANY, CATASAUQUA 1, Pa.**
Subsidiary of General American Transportation Corporation

TRADE LEHIGH MARK


## EQUIPMENT DEVELOPMENTS

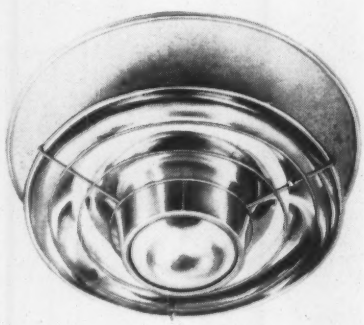
*Continued*

### Portable Heaters . . .

. . . for temporary or emergency heat. Units need no vents; combustion chamber assures complete combustion and eliminates odor, smoke, and visible flame. Burns kerosene, No. 1 or No. 2 fuel. Model "350" output capacity is 350,000 Btu per hr; model "80" has a 80,000 Btu per hr capacity. — *John Wood Co., Heater and Tank Div., Conshohocken, Pa.*

### Welded Copper Tubing . . .

. . . electronically welded tubing with OD's from ½ to 3½ in. and wall thicknesses from 0.017 to 0.110 in. This type of tubing also made from bronze and all other metals including the exotic alloys. — *Tubatron, Inc., 654 Third St., Newark, N.J.*

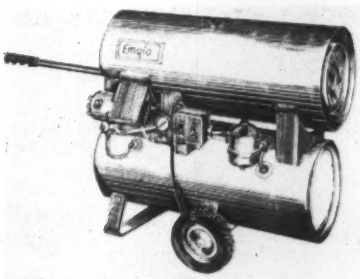


### Infra-Red Heater . . .

. . . a circular heating-light fixture combination. Surface mounted 800 w, 120 v unit has 24K gold plated reflector and circular quartz heating element. Literature sent on company letterhead requests. — *Infrared Corp. of America., Westbury, L.I., N.Y.*

## EQUIPMENT DEVELOPMENTS

*Continued*




### Portable Space Heaters . . .

. . . two sizes producing 120,000 and 240,000 Btu per hr. Each size available in manual, semi-automatic, and automatic control models. Units burn kerosene, No. 1, or No. 2 fuel oil under high pressure. High velocity fan delivers heated air up to 30 or 40 ft away. Operates on 115 v, 60 cycle circuits. — *Emglo Products Corp., Johnstown, Pa.*

### Smoke Recorder . . .

. . . a null-balance potentiometer with rapid traverse and adjustable sensitivity. Complete coverage from clear to blackout is achieved through chart graduated from 0-100. Charts also available with Ringlemann numbers. — *Photomation, Inc., 96 S. Washington Ave., Bergenfield, N.J.*

### Temperature Transmitter

. . . gas actuated unit for measurements as low as —400 F with 1 percent accuracy. Standard range spans of 100, 200, and 400 F. All-welded thermal systems interchangeable in field. Unit can be calibrated by two adjustments. Bulletin 98293 sent on request. — *Taylor Instrument Cos., 95 Ames St., Rochester 1, N.Y.*

# Take the legwork out of liquid measurement

Here's practical liquid measuring—the modern way . . . without roaming all over the lot! Liquidometer Gauges let you inventory distantly stored liquids at a glance.

Completely automatic Liquidometer Gauges can be located as far as 250 feet from tanks. Think what this centralized system can mean in man-hours saved—let alone the additional safety of personnel who no longer have to trudge to, or tamper with, hard-to-get-at tanks.

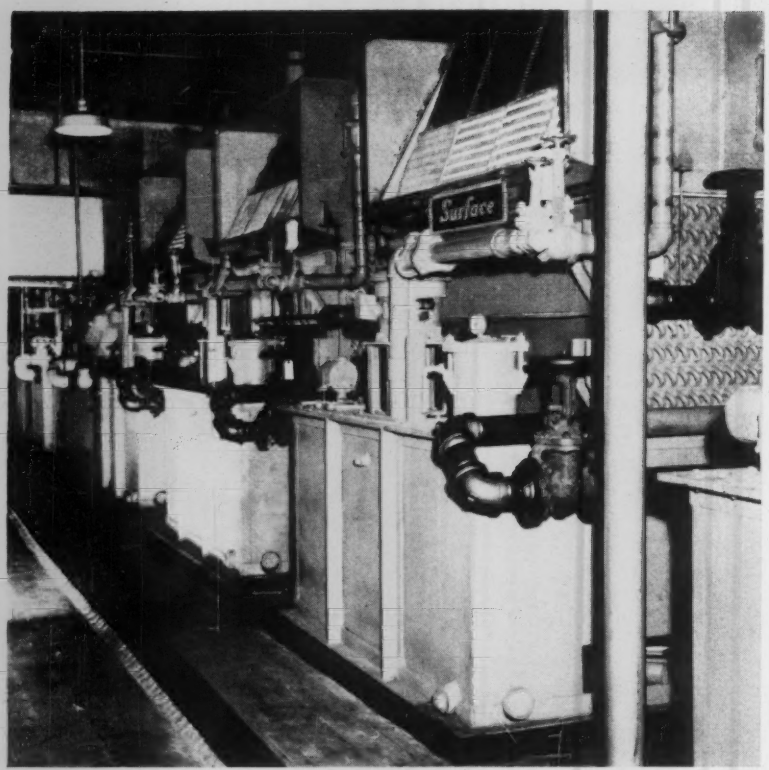
Simple to install, and requiring no maintenance, Liquidometer Gauges measure virtually all liquids conveniently, continuously, and correctly. There's a type available for practically every liquid measuring application.

**For complete details, write**

LIQUIDOMETER INSTRUMENTS

**THE LIQUIDOMETER CORP.**

**Dept. A, LONG ISLAND CITY 1, NEW YORK**




# 120 GRAINS CUT TO 45 IN 200,000 cfm OF AIR WITH 85° TOWER WATER

Without Kathabar, this job would have taken 1800 tons of refrigeration, at about 35F and reheating air from about 45F to 98F! With Kathabar the job took 63 hp instead of 2000. Ask the men who have seen Kathabar Type C units serve for years with practically no maintenance. Write for specific information.

Surface

**SURFACE COMBUSTION**

*Division of Midland-Ross Corporation*

*2384 Dorr St., Toledo 1, Ohio*

*Send facts on Kathabar systems for the following application:*

*name and title*.....

*company*.....

*street*.....

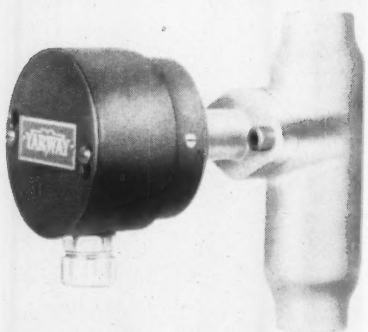
*city*.....*zone*.....*state*.....

## EQUIPMENT DEVELOPMENTS

*Continued*

### Solenoid Valves . . .

. . . with hermetically sealed epoxy-clad coils, line-tested at 2300 v submerged in water. Prevents coil failures or burnouts due to condensation, frost, oil, gasoline, fluid spray, and other corrosive liquids, gases, and vapors. Units have 24 v-60 cycle, 115 v-50/60 cycle, 208/230 v-50/60 cycle, or 115/230 v-50/60 cycle; all UL approved. — *Jackes-Evans Mfg. Co., 4427 Geraldine Ave., St. Louis* 15.




### Sensing Device . . .

. . . for detection and control of process variables. Element consists of a flexible, curved tube containing a spring wire for transmitting motion through pressure-tight wall. Deflection of tube end by change in level, flow, or other variable causes rotation of wire, which in turn will indicate change or operate switch. — *Yarnall-Waring Co., 102 E. Mermaid Lane, Philadelphia* 18.

## RECENT TRADE LITERATURE . . .

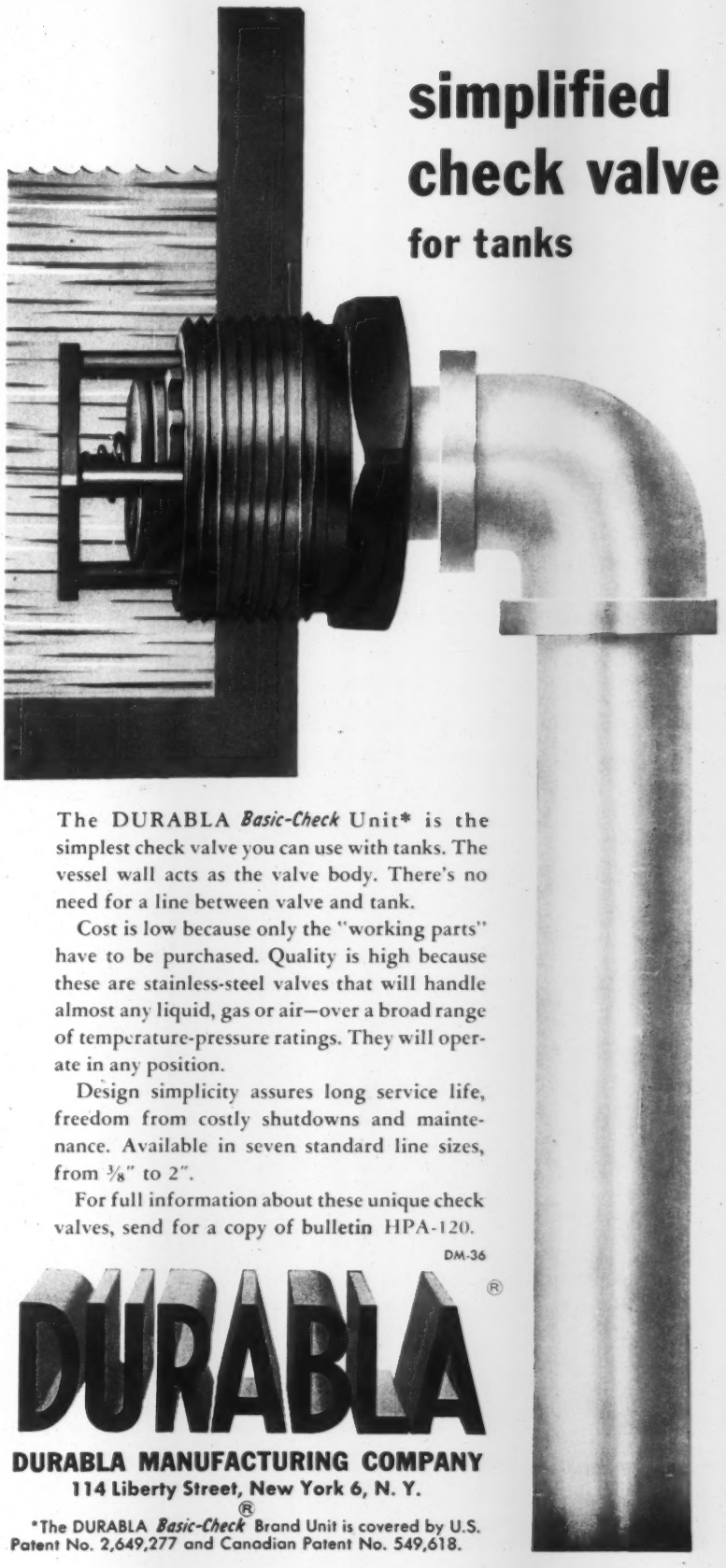
▶ *ADHESIVES, COATINGS, SEALERS*—described in 12 page catalog containing eight fold-out tables listing uses, characteristics, and general properties of over 170 different compounds. Selection and application data given, along with a cross reference index for this purpose. Make requests on company letterhead. *Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.*

▶ *AIR CONDITIONING EQUIPMENT*—described in eight page product folder LL-349-10. Lists centrifugal water chillers, air handling equipment, central station air conditioning units, packaged liquid chillers, radial compressors, condensing units, cooling and heating units, and fan-coil equipment. *Airtemp Div., Chrysler Corp., P.O. Box 1037, Dayton 1, O.*

▶ *AIR SAMPLING*—methods of measuring airborne pathogens described in "Bacterial Air Sampling, Manual 13." Lists references for further information. *Gelman Instrument Co., 106 N. Main St., Chelsea, Mich.*

▶ *ARMORED CABLE*—for instrument and control systems described in 12 page Bulletin 960. Detail given on various types of tubing, protective interlocked metallic armor, types of corrosion-resistant sheaths, and installation data. *Cresent Insulated Wire & Cable Co., Trenton 5, N.J.*

▶ *BAND CLAMPS, COUPLINGS*—industrial units featured with flanges and V-band joints in 44 page catalog, 803. Complete design information given. *Marman Div., Aeroquip Corp., 11214 Exposition Blvd., Los Angeles 64, Calif.*

**simplified check valve for tanks**

The DURABLA *Basic-Check* Unit* is the simplest check valve you can use with tanks. The vessel wall acts as the valve body. There's no need for a line between valve and tank.

Cost is low because only the "working parts" have to be purchased. Quality is high because these are stainless-steel valves that will handle almost any liquid, gas or air—over a broad range of temperature-pressure ratings. They will operate in any position.

Design simplicity assures long service life, freedom from costly shutdowns and maintenance. Available in seven standard line sizes, from ⅜" to 2".

For full information about these unique check valves, send for a copy of bulletin HPA-120.

DM-36

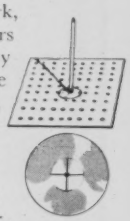
DURABLA®

**DURABLA MANUFACTURING COMPANY**
**114 Liberty Street, New York 6, N. Y.**

*The DURABLA *Basic-Check* Brand Unit is covered by U.S. Patent No. 2,649,277 and Canadian Patent No. 549,618.

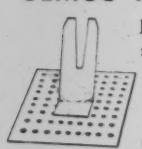
SAVE TIME—
SAVE MONEY
with these dependable
INSULATION
HANGERS

**GEMCO**
**Spindle Hangers and**
**W-A Self-Locking Washers**



Ideal for insulation work, Gemco Spindle Hangers are easily and quickly installed... with positive adhesion to concrete, brick or metal. W-A Self-Locking Washers pressed over spindles with minimum effort and lock insulation securely in place.

**GEMCO Pronged Hangers**



Designed especially for supporting various types of block insulation. Easily applied for positive adhesion. Prongs (available in various lengths from 1 3/16" to 6 7/8") bend over to hold insulation firmly in place.

**TUFF-WELD Nylon Hangers**

Two-piece hangers... with bases of tough, mold nylon and spindles of metal. Made especially for smooth surfaces. Spindles snapped into bases as needed; reduces inventory, storage space, freight costs. W-A Self-locking washers hold insulation securely in place.

**TUFF-BOND** Quik-Set Adhesive (for smooth or slightly irregular surfaces) and Improved General Purpose Adhesive (for rougher surfaces) assure permanent adhesion of hangers when used as directed. Write or wire for details and specifications.

**GOODLOE E. MOORE**
INCORPORATED
**DANVILLE 28, ILLINOIS**


## RECENT TRADE LITERATURE

*Continued*

▸ *CAST IRON BOILER* gas-fired unit described in new literature. Series "60" available in eight steam and water models, rated 90,000 to 360,000 Btu per hr input for all gases. Complete ratings, specifications, and dimensional data charted for easy reference. *Peerless Heater Co., Boyertown, Pa.*

▸ *CENTRIFUGAL PUMPS*—vertical single-stage split case models described in two page Bulletin 105-V. Units handle capacities to 6000 gpm with heads to 380 ft, continuous operation. *Aurora Pump Div., The New York Air Brake Co., Aurora, Ill.*

▸ *CHECK VALVES*—and the theme "how to eliminate dangerous line surges and water hammer in any piping system" are discussed in a bulletin. Cutaway photographs, force diagrams, and oscillographs explain principle and operation of valves. *Combination Pump Valve Co., Dept. 120, 851 Preston St., Philadelphia 4, Pa.*

▸ *CLEANING HOT WATER SYSTEMS*—form 324 explains how to tell if a system needs cleaning and what to do in such a situation. *Bell & Gossett Co., Morton Grove, Ill.*

▸ *COPPER PIPING*—for heating, air conditioning, and refrigeration described in 58 page manual Publication B-1. Latest information, tables, and other data given for copper piping and tube products. *Anaconda American Brass Co., Waterbury 20, Conn.*

▸ *COPPER TUBE*—described in 32 page handbook. Details firm's products and includes technical and installation data with guides to selection of correct sizes and types of tube and pipe, as well as soldering, brazing, and flared joint information. *Scovill Mfg. Co., Waterbury 20, Conn.*

▸ *CORROSION CONTROL* for open recirculating cooling water systems described in water conditioning data sheet "Pretreatment for Effective Corrosion Control." Discusses benefits of rapid film formation by pretreatment. *Betz Laboratories, Inc., Gillingham & Worth Sts., Philadelphia 24.*

▸ *COUPLINGS*—series designed for quick addition or removal of relief, flow control, or check valves in permanent hydraulic or pneumatic installations. Bulletin lists two sizes available in three finishes and three metals. "Rigid-Line" series also available with a choice of four end fittings and with any of eight seals. *Snap-Tite, Inc., Union City, Pa.*

▸ *CYLINDER ACTUATORS*—pneumatically positioned, described in Data Sheet 102. Used for precise positioning of many types of mechanical processing equipment. Complete specifications listed and application examples illustrated. *Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.*

▸ *DIFFUSION PUMPS*—described in 12 page catalog. Contains information on diffusion and booster pumps, shows speed curves for small, medium, and large models ranging from 1 to 32 in. sizes. Tabular specifications and outline drawings given for each pump. *NRC Equipment Corp., 160 Charlemont St., Newton 61, Mass.*

▸ *ELECTRIC, ELECTRONIC CONTROLS*—for commercial and industrial air conditioning installations discussed in "The Electronic Handbook." Explains theory, makes comparisons, and is completely illustrated. *Automatic Controls Div., Barber-Colman Co., Rockford, Ill.*

## RECENT TRADE LITERATURE

*Continued*

▸ *FASTENERS*—for mounting tubing, wiring, and similar hardware described in 76 page Bulletin 212 G. Lists materials and specifications, recommended applications, and latest techniques. Clamps, brackets, shims, and line supports covered. *TA Mfg. Co., Engineering Dept., 1607 Alger St., Los Angeles 39, Calif.*

▸ *FLEXIBLE CUSHION COUPLINGS*—one for high speed, high torque applications and another for attachment of flywheels of internal combustion engines, described in 20 page Bulletin 901. Complete engineering data, photographs, dimensional drawings, and selection tables included. *Dodge Mfg. Corp., Mishawaka, Ind.*

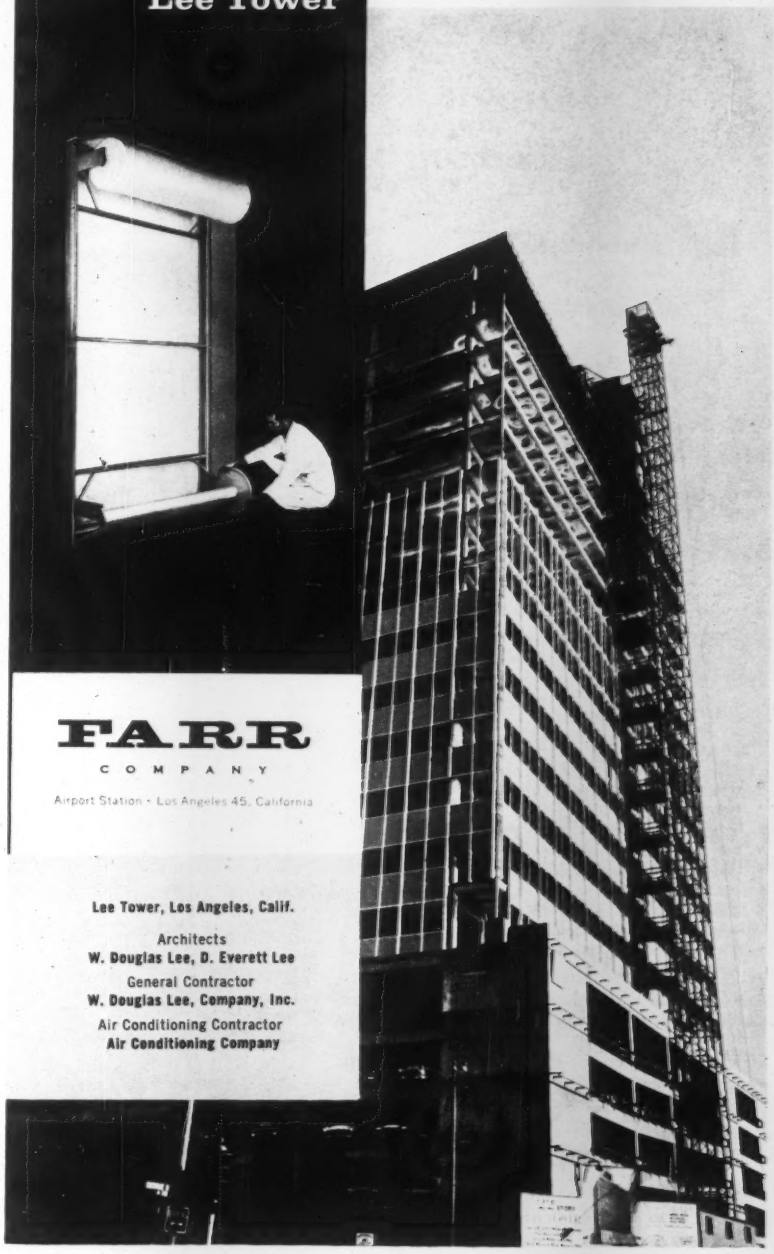
▸ *FLEXIBLE METAL HOSE*—in stainless and carbon steel described in 8 page catalog 539. Complete specifications including pressures, working temperatures, and installation methods given along with a comparative analysis of both types of metal for specific applications. Connectors in 16 standard models covered. *Cobra Metal Hose, 5059 S. Kedzie Ave., Chicago 32.*

▸ *FOAM INSULATION*—heat loss values for firm's "Roofmate," for uses under built-up roofs; "Styrofoam," for insulation on masonry walls and in cavity walls; and "Scoreboard," for perimeter insulation. Each chart lists values by type of comfort application and thickness of foam. Values expressed in U values. *The Dow Chemical Co., Building Products Sales, Midland, Mich.*

▸ *GLASS PROPERTIES*—of 32 commercial glasses described in 16 page booklet B-83 (Rev.). Contains information on new glasses as well as new sections on thermal expansion


**Farr Manual Roll-Kleens Will Handle 213,400 Cubic Feet of Air Every Minute In New Lee Tower**

The newest, tallest office building in Southern California—Los Angeles' Lee Tower—will depend on Farr Manual Roll-Kleens to clean 213,400 cfm more economically than any other type of renewable roll filter system. Farr Manual Roll-Kleens were specified because: ■ They have the same filtering efficiency as automatic types—at much lower cost. ■ They are delivered in modular kits for easy job-site assembly. ■ Over 100 sizes are available to meet any design need. For full information call your local Farr Representative, or write direct to Farr Company.



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*with Chain Guide*
**Changes that Danger Zone to a**
**SAFETY ZONE**

**. . . cuts costs when you SIMPLIFY PIPE LAYOUT**

When you modernize to make money, go all the way. Cut piping costs to minimum with planned simplification. Give your staff a free hand to effect economies . . at the same time, convert Danger Zones to Safety Zones. Equip every overhead valve wheel in your plant with Babbitt Adjustable Sprocket Rims with Chain Guides.

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8 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.


## RECENT TRADE LITERATURE

*Continued*

and optical properties. Thermal stress, heat transmission, electrical properties, corrosion resistance, and viscosity data given along with charts and graphs. Make requests on company letterhead. *Corning Glass Works, Corning, N.Y.*

▶ *HAND TACHOMETER*—with an accuracy of ±1 percent of scale described in four page Bulletin 103A. Unit available in three types, each with three speed ranges. *Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.*

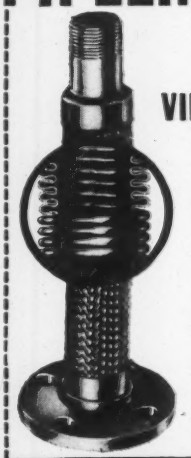
▶ *HEAT EXCHANGERS*—described in 24 page Catalog 601. Shows construction details, engineering data, and selection charts for all convertors and heaters, steam to water, and water to water heat transfer. *Old Dominion Iron & Steel Corp., Belle Isle, Richmond 3, Va.*

▶ *HEATING SCHOOLS ELECTRICALLY*—is the subject of four page Bulletin F00101-1. Installation illustrations, specification and product data, and a case history of electrically heated high school given. *Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8.*

▶ *INCINERATOR SELECTOR*—for diverse commercial applications such as use in hotels, restaurants, supermarkets, and schools. Slide rule guide gives type and size of unit recommended. *Morse Boulger, Inc., 80 Fifth Ave., New York 11.*

▶ *INDUCTION MOTORS*—squirrel cage units on basic dripproof designs described in 12 page bulletin. Motors range from 1 to 150 hp. Applications, performance characteristics, mechanical design variations, construction and insulation details, ratings, and dimensions given. *Century Electric Co., 18th & Pine Sts., St. Louis 3.*


**CALM Jittery PIPELINES**



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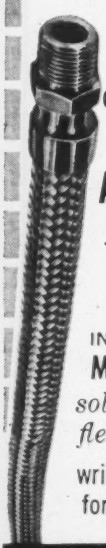

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## RECENT TRADE LITERATURE

*Continued*

▶ *INDUSTRIAL VENT PIPE*—described in 20 page brochure, TR-237A. Properties such as corrosion and weather resistance are given for firm's "Transite" pipe. Pipe sizes and dimensional information presented in tabular form. Both exterior and interior illustrations given, along with proper applications of jointing compounds. *Johns-Manville, 22 E. 40th St., New York 16.*

▶ *INFRA-RED HEATERS*—with over 5000 hr of tube-life guarantee described in A.I.A. File 30-C-44. Maximum heat output in 90 sec. *Apexto Products Co., 1821 N. Eastlake Blvd., Los Angeles 31.*

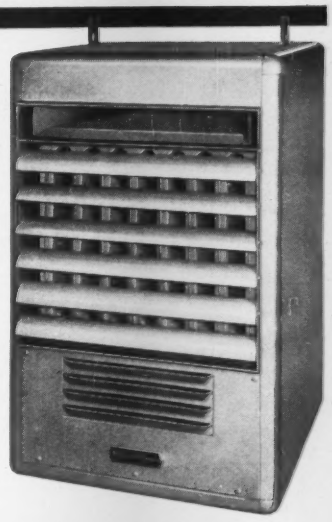
▶ *MAKE-UP AIR HEATERS*—described in 6 page Bulletin GFAS-60. Units are of modular or unitized construction, permitting horizontal or vertical downflow discharge with either wall or roof air inlet. Available in sizes from 1,500,000 to 4,500,000 Btu per hr and 15,000 and 50,000 cfm. *L. J. Wing Mfg. Co., Div. of Aero Supply Mfg. Co., Inc., Linden, New Jersey.*

▶ *MECHANICAL, HYDRAULIC TUBING*—electric-resistant welded carbon steel mechanical tubing, and firm's "Lectrosonic" cylinder and hydraulic line tubing, featured in eight page booklet, T-459. Contains information on "Lectrosonic" process and gives details of tube characteristics. *Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.*

▶ *MECHANICAL POWER TRANSMISSION EQUIPMENT*—described in eight page Catalog 23103. Products such as variable speed drives, belt drives, couplings, motor bases, pillow blocks, and others covered. *T. B. Wood's Sons Co., Chambersburg, Pa.*


# TOP ECONOMY, EFFICIENCY

## MUELLER CLIMATROL
### Gas Suspended Unit Heater



- Complete size range from 25,000 to 225,000 BTU/hr.
- Efficient, safe, all-welded, tubular-design heat exchanger
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- Convenient triple-duty lifting and hanging brackets
- Automatic fan and limit control plus summer switch
- AGA approved for Natural, Mixed, Mfd., Propane gas
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Water Diverting Valve

For year 'round comfort automation at a reasonable price, the Chatleff Vectrole Valve, Switching Element and Thermostat give you a complete comfort control system at a tremendous saving.

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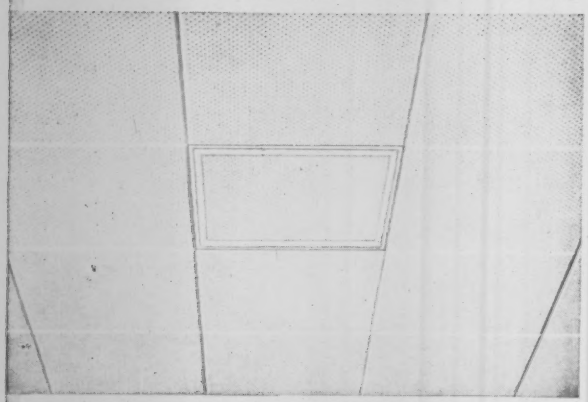
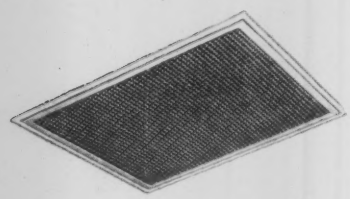
PERFORATED AIR OUTLETS

ADJUSTABLE — NON-ADJUSTABLE
SQUARE AND RECTANGULAR

the Ultimate in Application Versatility



AGITAIR PERFAIR diffusers provide the architect with a concealed air outlet that blends in perfectly with acoustical ceilings rather than calling attention to the mechanical installation. To complete the cycle of air distribution and conform with the architectural design, PERFAIR diffusers are also available as return or exhaust units in matching designs.



PERFAIR diffusers incorporate smartly designed mounting frames and exclusive AGITAIR removable diffuser cores which provide unmatched blow patterns in 1-2-3-4 way blows. The inner cores have an added feature... built-in direction controllers that provide deflection of the air stream from one or more sides individually in varying degrees from horizontal to downward delivery of air.

AGITAIR PERFAIR air diffusers are available for surface or tile mounting that will not only blend in with the ceiling design but will distribute the air noiselessly and draftlessly. AGITAIR PERFAIR is another genuine product designed for Better Air.

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185 MADISON AVENUE • NEW YORK 16, N. Y.

*BETTER PRODUCTS FOR*
*AIR DISTRIBUTION • AIR CLEANING • AIR EXHAUST*

## RECENT TRADE LITERATURE

*Continued*

▸ *PACKAGED COMPRESSORS*—designed for outdoor installation described in four page Bulletin C-460. Both horizontal and vertical models are air cooled in sizes from 3 to 70 hp. *Kramer Trenton Co., Trenton* 5, *N.J.*

▸ *PIPING FLEXIBILITY ANALYSIS*—using a computer service with a simplified do-it-yourself input feature described in 12 page booklet. Service provides analysis within 24 hr or less. Report given on analysis of a three-anchor system and two two-anchor systems. *The Service Bureau Corp.*, 125 *Park Ave., New York* 22.

▸ *PORTABLE HEATER*—with capacity of 50,000 Btu per hr described in two page data sheet, GB-130FA. Lists various applications, describes features, operation, and construction. Specification table also provided. *Hauck Mfg. Co.*, 124-136 *Tenth St., Brooklyn* 15.

▸ *RECEIVER GAGES*—described in eight page catalog 520. Specifications for both Bourdon tube and diaphragm-actuated types given. Also contains information on materials, dials, ranges, case styles and sizes. Tables give selection facts. *United States Gauge, Div. of American Machine and Metals, Inc., Sellersville, Pa.*

▸ *RELIEF VALVES*—"30 Questions and Answers" regarding the new American Standard Z21.22-1958 that will go into effect January 1, 1961, described in 16 page booklet. *Watts Regulator Co., Lawrence, Mass.*

▸ *ROOF VENTILATORS*—solid plastic units for removing corrosive fumes described in two page Engineering Data Sheet E-7801. Models in 10 standard sizes, 100 to 15,000 cfm. *Heil Process Equipment Corp.*, 12850 *Elmwood Ave., Cleveland* 11.

▸ *SEALING, CAULKING COMPOUND*—described in four page brochure, IN-318A. Characteristics of the asbestos-based, non-hardening sealer, "Duxseal," given, along with various applications. *Johns-Manville*, 22 *E. 40th St., New York* 16.

▸ *SOLUTION FEEDER*—for cooling tower systems and other applications described in two page Bulletin 88. Heavy duty 115 v motor introduces treatment into any line under suction or up to 100 psi pressure.

## RECENT TRADE LITERATURE

*Continued*

Operates outdoors in rain or snow. *Calgon Co., Hagan Center, Pittsburgh 30.*

▸ *SOUND CONTROL*—a complete listing of sound absorptive, sound isolating, and special purpose acoustical materials given in 20 page Catalog 61. Contains photographs, along with general and technical descriptions. *Elof Hansson, Inc., 711 Third Ave., New York 17.*

▸ *SPRING FASTENERS*—standard and special units in twin-prong or cone type impressions, and push-on types, described in 14 page catalog. Data arranged so selection of fastener by style, screw, or stud size is easily made. Tensile, torque, and other design requirements given. *George K. Garrett Co., Inc., Dept. 216, Torresdale Ave. at Tolbut St., Philadelphia 36.*

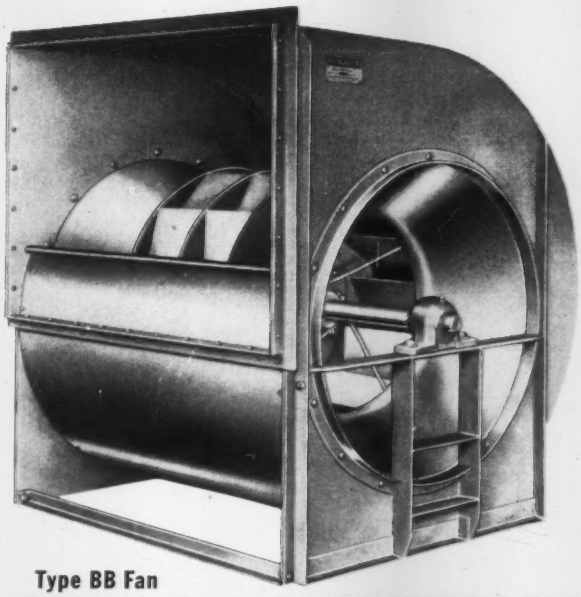
▸ *STEEL PIPE AND TUBING*—15 steels widely used in high temperature service described in six page folder, T-467. Includes chart containing data on tensile properties, thermal conductivity and expansion, creep strength, oxidation resistance, and other properties. *Babock & Wilcox Co., Beaver Falls, Pa.*

▸ *TANK HEATERS*—three models described in eight page Bulletin 300. Vertically mounted heaters for large storage tanks; horizontally mounted units for working tanks and where low liquid level heating is required; immersion type tank heaters for use with tank cars and tank trucks. Application and dimensional data given. *Brown Fintube Co., Elyria, O.*

▸ *THERMAL SYSTEM COMPONENTS*—described in 12 page specification sheet S-690-1a. Gives sizes, lengths, materials, etc. for bulbs and tubing of gas, mercury, and vapor-actuated thermal systems. Also describes new vibration-resistant gas-actuated thermal system that uses miniature bulbs. *Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Philadelphia 44.*

▸ *TRANSFER DUCTS*—obstruct sound transmission while passing maximum amount of air described in Bulletin B-12. Can be installed in a wall, ceiling, or door. *Silence Inc., P.O. Box 21, Farmingdale, N. Y.*

▸ *TUBEFORMING MACHINE*—for manufacturing thin-wall spiral lockseam tubing described in 12 page

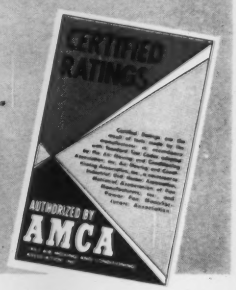



Type BB Fan

Aladdin
AIR HANDLING EQUIPMENT

For EFFICIENCY and QUIET OPERATION...

CERTIFIED PERFORMANCE




**ALADDIN Type BB Fans** are the first choice of many engineers for heating, ventilating and air conditioning jobs. Designed for low rotational speeds and high efficiency, these fans insure that stable performance from free delivery to shutoff that engineers have come to expect of this type of equipment.

In designing the BB Fan, Aladdin engineers have refused to short-cut quality, each fan is ruggedly built and is backed by thirty-five years of experience and manufacturing know-how.

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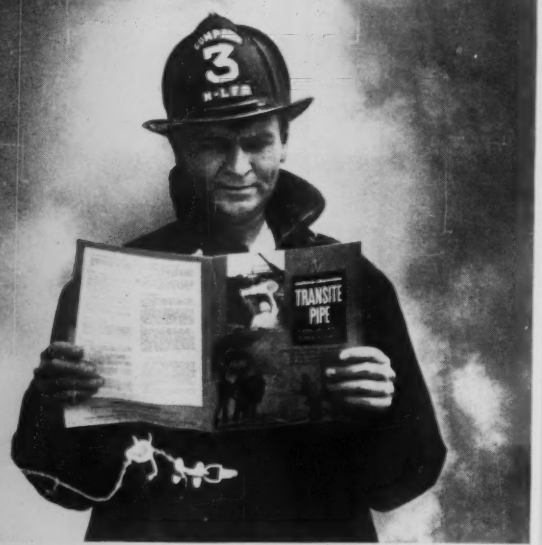


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COUNTY _____ STATE _____


## RECENT TRADE LITERATURE

*Continued*

brochure. Unit produces tubing in diameters up to 32 in. from strip of 0.015 to 0.037 in. thickness of materials such as aluminum, copper, zinc, and steels of the ordinary, stainless, acidproof, galvanized, and plastic-coated variety. *Spiro, U.S.A., 20 N. Wacker Dr., Chicago 6.*

▸ *TUBING AND PIPE*—for corrosion resistant service or elevated temperature and/or pressure service, described in Bulletin T-456. Shows chemical analysis of standard carbon, alloy, and stainless tubing steels used in such services. Cross-indexed to associate grade and ASTM Specifications with firm's nicloy, croloy, and specialty tubing steels. *Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.*

▸ *TURBO BLOWERS*—124 separate models described in four page Bulletin 300. Units operate over a pressure range of 4 to 44 psi, available in direct, V-belt, or coupled drives. Rated volumes are 60 to 14,300 cfm. Power supplied by electric motors, steam turbines, gas, gasoline, or diesel engines. *The North American Mfg. Co., 4455 E. 71st St., Cleveland 5.*

▸ *VALVE LUBRICANT GUN*—portable, air-operated unit for large scale applications described in six page bulletin. Unit weighs only 53 lb and has a 100:1 pressure ratio and double-action piston. *Meter and Valve Div., Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8.*

▸ *VIBRATION ISOLATOR*—for shock and vibration produced by machinery developing predominantly horizontal forces described in Bulletin 60-04.14. Unit handles up to 4000 lb per mount. *Barry Controls, Div. of Barry Wright Corp. 765 Pleasant St., Watertown 72, Mass.*

▸ *WELDING REDUCERS*—wrought iron units, concentric and eccentric in sizes from 1 through 24 in. described on illustrated price list. *Steel Forgings, Inc., P.O. Box 276, Foot of Fannin St., Shreveport, La.*

▸ *WOOD DETERIORATION*—in cooling towers, its causes, symptoms, and suggested cures discussed in Reprint 85. Leaching, delignification, and microbiological attack featured as the three principal types of deterioration found in wood towers. *Nalco Chemical Co., 6216 W. 66th Place, Chicago 38, Ill.*

## WE HEAR THAT . . .

▶ *THE YELLOTT SOLAR ENERGY LABORATORY*, Phoenix, Ariz., has been established to carry out research, development, and testing programs for industry, the armed services, and other branches of government, and for research institutions by *JOHN YELLOTT ENGINEERING ASSOCIATES, INC.*

▶ Construction and design standards of heat transfer equipment will be published next January by *THE FUEL OIL AND WATER HEATER MANUFACTURERS ASSOCIATION, INC.* Distribution will be to architects, engineers, and other interested parties.

▶ An advanced research center will be built at Middleton, Wis. by the *A. O. SMITH CORP.* The center will cost an estimated $2 million and will be in addition to the firm's Milwaukee research center. Activities in the new facility are scheduled for the middle of 1961.

▶ *INSTO-GAS CORP.* has acquired *SUN-HEAT, INC.*, placing the firm in the electric heating field. Sun-Heat's operations will continue at Holt, Mich.

▶ *CONTROLS CO. OF AMERICA* has announced the organization of *CONTROLS FRANCE* with a new 27,000 sq ft plant in Schirmeck, France. Operations are scheduled to begin in January 1961.

▶ The merger of Imperial Brass Mfg. Co., Niles, Ill., and Eastman Mfg. Co., Manitowoc, Wis. has been approved by shareholders of both firms. The general offices of the new *IMPERIAL-EASTMAN CORP.* are located in Chicago.

▶ *KRUSE, FLAHERTY & ASSOCIATES*, consulting engineers of Wayne, N.J. have opened their new offices in Jersey City, N. J. The firm is engaged in the engineering and design of commercial buildings, industrial plants, and environmental and other specialized test facilities.

▶ *ROBERTSHAW-FULTON CONTROLS CO.* recently opened its new *ROBERTSHAW THERMOSTAT DIV.* manufacturing plant in Youngwood, Pa. The plant provides 360,000 sq ft of working area. Its cost was $4 million. The firm announced also the purchase of six acres of property in Richman, Va. to be used for corporate headquarters.

▶ *EUTECTIC WELDING ALLOYS, SOUTHWESTERN DIV., INC.* has moved into expanded and improved quarters at 2366 Irving Blvd., Dallas.


FOR MAXIMUM HEATING
OR EXHAUSTING EFFICIENCY
AT LOWEST COST

Patents 2,722,372 and 2,855,874 and Patents Pending plus Exclusive Foreign Patents.

...Specify

**Quickdraft**

POWER-DRAFT UNITS
DESIGNED FOR RESIDENTIAL,
COMMERCIAL AND INDUSTRIAL
APPLICATIONS

★ No motors, fans or bearings in exhaust line ★ Needs no stacks ★ Acid-resisting vitreous enamel finishes ★ Extremely high static pressures now available

FOR HEATING PLANTS AND INCINERATORS . . . *Quickdraft* provides constant draft for efficient and economical combustion. It eliminates pulsating or chattering, puffing, smoking and sooting. Costly, tall, unsightly stacks are unnecessary.

FOR INDUSTRY . . . *Quickdraft* now offers extremely high static pressures for EXHAUSTING corrosive gases, abrasives and paint sprays . . . for CONVEYING all types of bulk materials or wastes that can be moved by air.

FOR MOVING AIR in or out of buildings through ducts . . . *Quickdraft* is outstanding in performance and efficiency.

9010-QD

IMPORTANT NOTICE

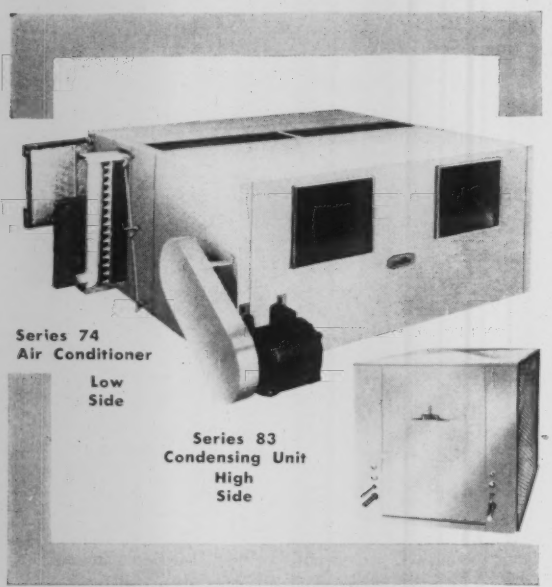
To withstand corrosive gases, all *Quickdraft* units are available in standard acid-resisting vitreous enamel, No. 316 Stainless Steel, rigid plastics (P. V. C.) and with plastic and Fiberglass coatings.

*Write today for Quickdraft Engineering Data.*

**Quickdraft**
**CORPORATION** P. O. BOX 87-K, CANTON 1, OHIO

usAIRco

40 years experience in air conditioning




RUGGED CONSTRUCTION

Built for Efficient Performance, Long Life, Trouble-Free Operation

WRITE FOR
PRODUCT BULLETINS
74 and 83

See Us in Chicago
Booth No. 648

United States Air Conditioning Corporation
Delaware, Ohio

## WE HEAR THAT

*Continued*

▸ *REPUBLIC STEEL CORP.* has licensed the *HILL HUBBELL CO., DIV. OF NATIONAL MALLEABLE AND STEEL CASTINGS CO.*, to use "Republic X-Tru-Coat" for coating steel pipe.

▸ A 28,000 sq ft fabricating plant is being built for the *LIMBACH COMPANY* in Medford, Pa. Scheduled for completion in March 1961, the structure will house 60 employees of the mechanical contracting firm. The firm will also open a permanent office and plant in Boston.

▸ *ROYCO INSTRUMENTS, INC.* has moved its offices and production facilities to a 6250 sq ft structure in Palo Alto, Calif.

▸ Shareholders of the *MARSHALLTOWN MFG. CO.*, Marshalltown, Ia. have approved the sale of the firm to the *ELECTRIC AUTOLITE CO.*

▸ *SCHAEVITZ ENGINEERING* will begin production of a complete line of motors which will produce the mechanical energies required by the control instruments already manufactured by the firm.

▸ The *SPRING DIV. OF BORG-WARNER CORP.* has purchased the Brummer Seal Co. in Chicago Heights, Ill. The acquisition will be known as the *BRUMMER SEAL DIV. OF BORG-WARNER CORP.*, but will be operated as part of the Spring Div.

▸ *THE TRANE CO.* has begun construction on a 84,000 sq ft plant at Kearns, Utah, a suburb of Salt Lake City. Cost of the plant is $1.5 million.

▸ *WOLVERINE TUBE, DIV. OF CALUMET & HECLA, INC.* has opened its new sales office and mill depot in Birmingham, Ala., located at 3607 1st Ave. South.

▸ *CUTLER-HAMMER, INC.* has begun production in its new 35,000 sq ft plant in Belmont, Calif.

▸ *DRYER DYNAMICS* is the new name of the former Dryer Electric Corp. The firm has recently moved into new and larger quarters in Lyndhurst, N.J.

▸ The formation of *GLOBAL AIR CONDITIONING CORP.* as a wholly owned subsidiary of *TUCK-AIRE FURNACE CO.* has been made. Global will take over all the manufacturing and sales function for air conditioning equipment and components formerly handled by Tuck-Aire.

## WE HEAR THAT

*Continued*

▶ *SKINNER PRECISION INDUSTRIES, INC.* is the new name of the former Skinner Chuck Co., New Britain, Conn.

▶ Construction of a 80,000 sq ft plant in Worcester, Mass. for the *JAMESBURY CORP.* will begin in the Spring of 1961.

▶ Construction will begin on a 190,000 sq ft plant in Danville, Va. for *CORNING GLASS WORKS.*

▶ *BORG-WARNER CORP.* will spend a record $40 million on new plants and equipment in 1961.

▶ The establishment of the *WALTON INSTITUTE OF HUMIDIFICATION*, a non-profit organization for research and the dissemination of information in the field of humidification, has been made by *WALTON LABORATORIES, INC.*, Irvington, N.J.

▶ A new home for its air conditioning operations will be provided by a 115,000 sq ft plant recently leased by the *EMERSON RADIO & PHONOGRAPH CORP.* The plant is expected to be in operation within the next few months.

▶ Construction is under way for a 90,000 sq ft extention to the existing 170,000 sq ft facility of the *WORTHINGTON CORP.* plant in Decatur, Ala.

▶ *BLACK AND DECKER MFG. CO.* has opened its 50th factory service branch in the U.S. with the location of the third such branch in Chicago.

▶ *HERSHMAN SHEET METAL WORKS, INC.* has acquired two one-story buildings and a 35,000 sq ft yard adjacent to its present structure for storage, parking, and off-street loading and unloading. One building is to be occupied December 1, 1960.

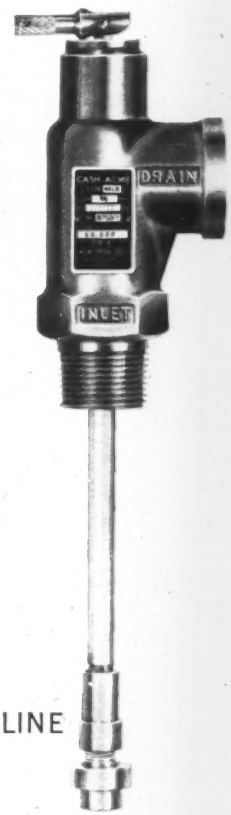
▶ *A. M. BYERS CO.* will enter the steel pipe market effective immediately. Inventories will be maintained at Sharon, Pa.

▶ *MUELLER BRASS CO.* has moved its Denver, Colo. branch into new and expanded quarters at 485 Osage St. The 20,000 sq ft structure will house the firm's sales and warehousing facilities in that area.

▶ *HUPP CORP.* has acquired the assets of Horace L. Smith Jr., Inc., Richmond, Va., thermodynamics engineers specializing in radiant heating and drying. The acquisition will be operated as a subsidiary under the name *SMITHERM CORP.*


TYPE NFLX SERIES

automatic reseating temperature and pressure relief valve




Another quality-first product in INDUSTRY'S WIDE, WIDE LINE OF AUTOMATIC VALVES

TOTALLY NEW.....

SETTING NEW STANDARDS OF SAFETY IN RESIDENTIAL WATER HEATER PROTECTION

Here's a relief valve engineered with a fresh outlook on hot water heater protection. The NFLX upgrades relief valve performance . . . raises safety margins in heater protection to approach instrument-like perfection.

**Full ½" Seat Diameter:** Assuring instant full relieving capacity.

**Larger Flow-Ways:** Precision cast valve body has larger flow-ways for maximum performance despite possible liming and scale accumulation.

**Body Seat Elevated Above Drain Outlet:** Prevents accumulation of solids around seating surface.

**Newly Designed, More Powerful Thermostatic Element:** Provides 35% more "push" for quicker more positive temperature relief. Solid-filled element has no liquids to leak . . . remains accurately sensitive for the life of the valve.

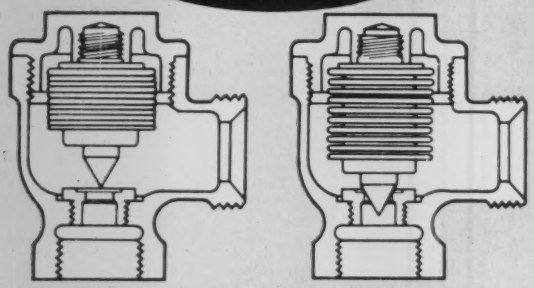
**The NFLX fully meets all standards of FHA, AGA, requirements.** Provides more than adequate protection as specified by ASA-1958 and FHA MPS-300.

A. W. CASH VALVE MFG. CORP.
666 E. Wabash Ave.
Decatur, Illinois

CASH AUTOMATIC VALVES ACME

# SIMPLE, TROUBLE-FREE VACUUM THERMOSTAT DESIGN ASSURES EFFICIENT, ECONOMICAL STEAM TRAP OPERATION

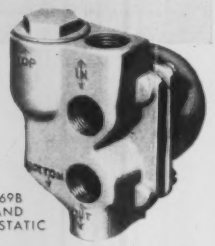
Sterlco®
STEAM TRAPS



Thermostat in open position — Thermostat in expanded position

1. Sterlco Traps operate efficiently regardless of pressure variations. *Vacuum thermostat* compensates for pressure changes.
2. While vacuum in thermostat remains intact, traps require no attention other than normal maintenance.
3. If, through damage or normal wear, the vacuum is lost, the thermostat expands, closing off trap and radiator. Locating source of trouble is made quick and easy. Trap maintenance is greatly simplified.
4. Closed traps mean no wasted steam . . . vacuum on vacuum systems remains normal . . . condensation and vacuum pumps are not endangered by steam in return lines.

7-50A ANGLE RADIATOR TRAP

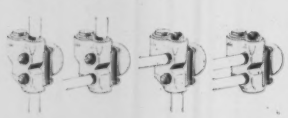


MODEL 69B FLOAT AND THERMOSTATIC TRAP

The Sterlco line covers the whole range of low, medium and high pressure radiator traps. Every unit thoroughly tested . . . components inspected and tested during manufacture; completed traps given operating tests before shipment. Thermostats and seats replaceable without shimming or adjustment.

*For complete information on Sterlco Steam Traps, write for Bulletin 102.*

Sterlco F & T traps perform dual function: float trap releases condensate water . . . thermostatic trap vents air. No. 69B has two inlets, two outlets making four installation positions possible . . . saves time, space and piping.



Leaders in temperature controls since 1916

**Sterling inc.**

5202 W. Clinton Ave., Milwaukee 23, Wisconsin


# WHO'S WHAT . . .

***(New personnel, promotions)***

▸ *DODGE MFG. CO.* — Fred J. Ebeling, director of sales.

▸ *SOLAR AIRCRAFT CO.* — Paul A. Pitt, vice president of engineering.

▸ *JOSAM MFG. CO.* — Edward J. Dwyer, chief engineer and midwest regional manager.

▸ *CAINS MFG., INC.* — A. L. Thys, sales manager.

▸ *BJORKSTEN RESEARCH LABORATORIES* — Norman A. Rautiola, assistant to the executive vice president.

▸ *C. A. OLSEN MFG. CO.* — Ronald W. Lindsay, director of marketing.

▸ *CARRIER AIR CONDITIONING CO.* — Philip F. Little, consultant for special applications of centrifugal refrigeration machines; and Clarence E. Torrey, Jr., vice president.

▸ *CHRYSLER CORP.'S AIRTEMP DIV.* — Thomas W. Kirby, vice president of marketing.

▸ *BETTCHER MFG. CORP.* — R. F. Sharon, member of the board of directors and vice president of the *PANEL-BLOC DIV.*

▸ *CHASE BRASS & COPPER CO.* — John J. McGonagle, New York district manager in the warehouse div.

▸ *ACME STEEL CO.* — Fred M. Gillies, senior consultant for steel operations and member of the board of directors.

▸ *PITTSBURGH CHEMICAL CO.* — Bernard S. Pawlowski, plant chemist; and William E. Milligan, plant engineer.

▸ *AIR CONDITIONING DIV., AMERICAN RADIATOR & STANDARD SANITARY CORP.* — Donald W. Bowman, manager, marketing control and administration.

## WHO'S WHAT

*Continued*

▶ *ARKLA AIR CONDITIONING CORP.* — K. Albert Miegl, chief engineer; and Robert K. Spear, assistant to the vice president of engineering, research, and development.

▶ *SCHAEVITZ ENGINEERING* — Dr. Juls Miller, head of the electromagnetic devices department.

▶ *THE JOHNSON FURNACE CO.* — C. A. Olsen, chairman of the board of directors.

▶ *PLUMBING—HEATING—COOLING INFORMATION BUREAU* — Lee Martin, president of *NIBCO INC.*, president.

▶ *PERMAGLAS DIV., A. O. SMITH CORP.* — Lee Zoeckler, manager of sales and product training.

▶ *HOOKER CHEMICAL CORP.* — Dr. Chris A. Stiegman, vice president of research and development; and Charles C. Hornbostel, vice president of finance.

▶ *NATIONAL INSULATION MANUFACTURERS ASSOCIATION* — Hugh T. Williams, manager of engineering and industrial sales, *OWENS-CORNING FIBERGLAS CORP.*, president.

▶ *FRICK CO.* — William B. Clements, member of the board of directors.

▶ *WAUKESHA MOTOR CO.* — Charles E. Nelson, Jr., president.

▶ *AIRCRAFT POROUS MEDIA, INC.* — Leslie Seawert, S. R. Jupiter, and Marcel Verrando, assistant chief engineers.

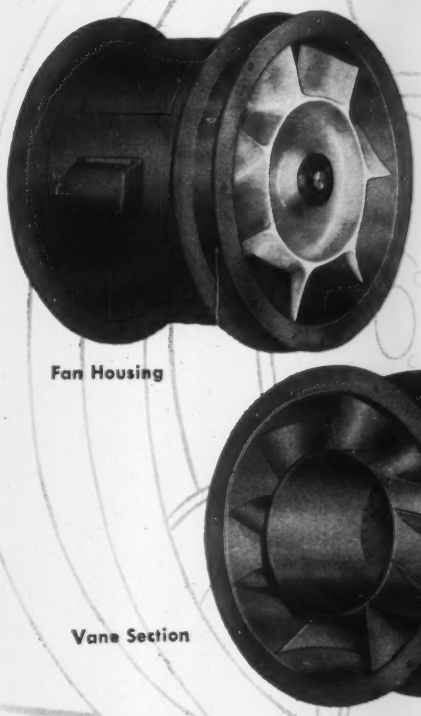
▶ *SIMPSON ELECTRIC CO.* — Leroy E. Tice, chief field engineer.

▶ *WOLVERINE TUBE, DIV. OF CALUMET & HECLA, INC.* — E. C. Walter, manager, Detroit plant; V. A. Zatell, manager, Inkster, Mich. plant; E. F. Hill, director of new products; and R. M. Frink, director of contract planning.

▶ *LIMBACH CO.* — F. Allen Mansfield, manager of Boston branch.


another outstanding design development from

Aerovent




direct-connected
vaneaxial fans
with removable vane sections

Engineered for high-pressure, high-velocity air distribution systems, these units feature a unique removable vane section which simplifies installation and permits easy access for routine cleaning and maintenance.

Available in 30 models in sizes 18" to 48" for capacities from 3230 to 67,300 cfm with special design features for all application requirements.

Write for Bulletin 475

Air deliveries of all Aerovent equipment are tested and rated in accordance with established and accepted codes and each unit is guaranteed by the manufacturer to deliver its rated performance.

CERTIFIED PERFORMANCE

Aerovent

Aerovent
FAN COMPANY, INC.
ASH AND BRANCH STREETS PIQUA, OHIO

## WHO'S WHAT

*Continued*

▶ *NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION* — John S. Blackburn, chairman, steel group, rigid metallic conduit and electrical metallic tubing section.

▶ *PITTSBURGH CORNING CORP.* — Dr. D'Eustachio, director of research.

▶ *WORTHINGTON CORP.* — Frank J. Nunlist, vice president of operations.

▶ *DETROIT CONTROLS DIV., AMERICAN RADIATOR & STANDARD SANITARY CORP.* — Herbert J. Zurstadt, project engineer.

▶ *WALWORTH CO.* — Dr. Forest C. Monkman, vice president of research and engineering.

▶ *HYDROMATICS, INC.* — John A. Wiedmann, chief engineer of the industrial div.

▶ *LAU BLOWER CO.* — Charles C. Miley, sales manager.

▶ *KEASBEY & MATTISON PLANT NO. 1* — Edward F. Mitchell, plant engineer.

▶ *AIR MOVING AND CONDITIONING ASSOCIATION, INC.* — Robert W. Krogstad, association president.

▶ *BORG-WARNER CORP.* — Dr. Donald W. Collier, vice president of research.

▶ *GEORGE W. DAHL CO., INC.* — Robert C. Wing, general sales manager.

▶ *DUNHAM-BUSH, INC.* — Russell S. Townsend, chief engineer for the Michigan City, Ind. plant.

▶ *FARRIS ENGINEERING CORP.* — George E. Ellis, general sales manager.

▶ *BRYANT MFG. CO.* — Robert K. Eskew, vice president and director of engineering.

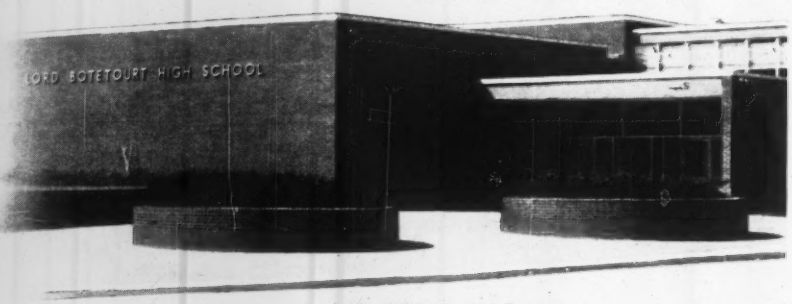
▶ *JACKES-EVANS MFG. CO.* — Robert S. Lehleitner, sales manager *CONTROLS DIV.*


# LEADING ENGINEERS SPECIFY A MODERN STOKER*

Two 500 lb. per hour Combustioneer stokers were installed in this beautifully modern Virginia high school after coal was recommended and Combustioneer stokers were specified by the leading firm of Hayes, Seay, Mattern and Mattern, architects and engineers.

Combustioneer gives automatic firing and coal provides for greatest economy in heating.

*COMBUSTIONEER STOKER INSTALLATION
LORD BOTETOURT HIGH SCHOOL
BOTETOURT COUNTY, VIRGINIA




*Architects and Engineers:*
HAYES, SEAY, MATTERN AND MATTERN
ROANOKE, VA. • NORFOLK, VA.
WASHINGTON, D. C.

C

## BITUMINOUS COAL EQUIPMENT, INC.
**Indianapolis, Indiana**

## WHO'S WHAT

*Continued*

▶ *MINNEAPOLIS-HONEYWELL REGULATOR CO.* — Arthur O. Dietrich, manager of advertising and sales promotion, industrial operations; Dean B. Randall, director of advertising and sales promotion, Minneapolis-based divisions; and Charles W. Bowden, industrial sales manager, International Div.

▶ *MARBON CHEMICAL DIV., BORG-WARNER CORP.* — William A. Suiter and Rhoda M. Stewart, vice presidents.

▶ *TORRINGTON MFG. CO.* — Charles A. Hathaway, vice president.

▶ *WELBILT AIR CONDITIONING AND HEATING CORP.* — John E. Craig, general sales manager.

▶ *THATCHER FURNACE CO.* — Justin H. Dinehart, chief engineer.

▶ *OPW-JORDON CORP.* — R. J. Peters, manager of product and market research; M. W. Hott, manager of engineering and manufacturing; and D. H. Culver, advertising manager.

▶ *BLACK AND DECKER MFG. CO.* — Charles L. Costa, field manager product service div.

▶ *RAYBESTOS-MANHATTAN, INC.* — R. B. Hazard, director.

▶ *A. M. BYERS CO.* — Joseph Smith, advertising manager.

▶ *INDUSTRIAL DIV., AMERICAN RADIATOR & STANDARD SANITARY CORP.* — A. J. Simpson, product manager fan lines.

▶ *NYTRONICS, INC.* — David P. Ebaugh, chief of the Industrial Engineering Department, *AUTOMATIC PRODUCT DIV.*

▶ *IMPERIAL-EASTMAN CORP.* — F. C. Shafer, chairman of the board; W. C. Schuknecht, vice chairman of the board; W. C. Musham, president; and vice presidents, C. H. Benson, M. W. Brose, G. J. Duerr, G. E. Franck, G. N. Jagemann, and F. W. Winter.


**Eliminate** PIPELINE CORROSION, ABRASION, NOISE, VIBRATION, EXPANSION

**CONDOR FLEXIBLE RUBBER PIPE**

- Flexible, Strong, Light Weight
- For Working Pressures up to 250 psi
- Lasts 3 to 10 times longer than Iron or Steel!
- Easy to install
- Available with quick coupling, safe Hydro-Lock Flange

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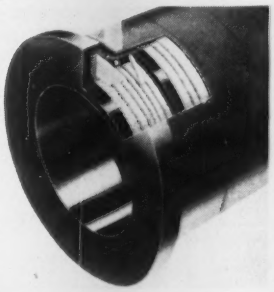

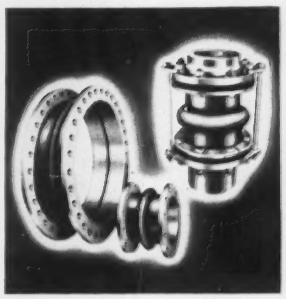

**R/M RUBBER EXPANSION JOINTS**

- Overcome Expansion Stress
- Avoid Misalignment
- Maximum Resistance to Shock
- Require No Gaskets

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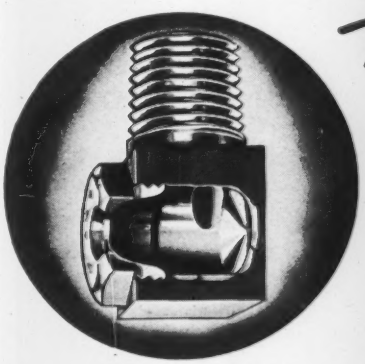
RM1038

Engineered Rubber Products . . More Use per Dollar

**RAYBESTOS-MANHATTAN, INC.**

MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

RM



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**NOZZLES for AIR WASHERS**

These are "non-clogging" nozzles with a single large tangential lead hole to the swirl chamber that will never clog from any impurities small enough to pass through the orifice. Swirl chamber is conical on both ends and pivots liquid like a top to produce an exceptionally fine, evenly distributed, balanced spray of about 80° included angle. Wider spray angles up to 130° can be furnished to order.

Standard material Brass. Also available in Stainless Steel and Monel. Pipe sizes from 1/8" to 1". 1/4" size is 1-5/16" long and made from 5/8" square stock.

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**Monarch** MFG. WORKS, INC.
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**SPACE-SAVING EFFICIENCY & FLEXIBILITY**

**with the Roberts-Gordon "CYCLO-JET"**

Here's the hottest news in years for commercial and industrial heating! Roberts-Gordon's *new*, complete line of "Cyclo-Jet" power pressure burners achieves a unique concept of peak efficiency fuel combustion in a truly compact package. It's the all-new "Cyclo-Jet" burner head that does it!

- **Positive Combustion Air Control Insures Maximum Fuel Economy**
- **Uniform, Compact Flame Pattern over Wide Firing Range**
- **Completely Automatic Control System**
- **Gas, Oil or Dual Fuel Gas/Oil Models**
- **Capacities to 2,600,000 BTU's/hr. input**

Factory assembled and tested, the "Cyclo-Jet" Burner is a *complete* fuel burning device and control system. Combining high efficiency with great compactness, the new "Cyclo-Jet" Burner Head is extremely flexible and simple to install.

Unique design of burner head forces gas and air into combustion chamber with cyclonic turbulence. This gives compact flame configuration with resulting high heat release, facilitating firing of equipment normally presenting difficult combustion problems.

Accurate combustion air control with either fuel eliminates need for induced draft fan or tall chimney. Fixed firing rate, two-stage or fully modulating gas control systems are available. Dual gas/oil burners are designed for quick manual or automatic fuel changeover. Low-fire start and pre- and post-purge are optional. Totally enclosed control panel is standard. Panel lights indicate when controls are energized. Electronic-interrupted pilot control system gives safe, positive main flame supervision. Fully factory guaranteed.

Cash In On the Profit Opportunities of the Revolutionary New "Cyclo-Jet" Power Pressure Burner Line NOW! Contact Your Roberts-Gordon Dealer or Write Us Direct.

ROBERTS GORDON

**ROBERTS-GORDON APPLIANCE CORP.**

**44 Central Ave., Dept. HP, Buffalo 6, N.Y.**

*In Canada — Grimsby, Ontario*


# MEETINGS & CONVENTIONS

*DEC.* 12-14 — *American Nuclear Society, winter convention.* Mark Hopkins and Fairmont Hotels, San Francisco. Information: Dr. E. Zebroski, General Electric Co., P.O. Box 254, San Jose, Calif.

*DEC.* 12-15 — *Industrial Building Exposition and Congress.* New York Coliseum. Information: Clapp & Poliak, Inc., Management, 341 Madison Ave., New York 17.

## 1961

*JAN.* 23-26 — *National Plant Maintenance & Engineering Show.* International Amphitheater, Chicago. Information: Clapp & Poliak, Inc., Management, 341 Madison Ave., New York 17.

*JAN.* 30-*FEB.* 2 — *University of Illinois and The Institute of Boiler and Radiator Manufacturers, 13th Short Course on Hydronic Heating and Cooling Systems, "Fundamentals of Being Competitive Through Managerial and Technical Training."* University of Illinois, Urbana, Ill. Information: Division of University Extension, 725 S. Wright St., Champaign, Ill.

*FEB.* 13-16 — *American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., semi-annual meeting.* Conrad Hilton Hotel, Chicago. Information: ASHRAE, 234 Fifth Ave., New York 1.

*FEB.* 13-16 — *International Heating and Air Conditioning Exposition.* International Amphitheater, Chicago. Information: E. K. Stevens, International Exposition Co., 480 Lexington Ave., New York 17.

*MARCH* 27-31 — *Third National Symposium on Temperature — Its Measurement and Control in Science and Industry.* Sponsored by American Institute of Physics, Instrument Society of America, and National Bureau of Standards. Columbus, Ohio. Information: W. R. Tilley, National Bureau of Standards, Washington, D.C.

## "GOES ON FAST... SEALS TIGHT!"

Cut assembly time with KEY-TITE®, the tight sealing waterproof pipe joint compound. It's ideal for water, gas and low pressure lines — safe for potable liquids — contains no toxic ingredients. Actually lubricates while it seals — joints don't freeze.

Key-Tite is easy to apply with a brush — no crumbling or waste. Extra long open-can life eliminates thinning and stirring.

Available in the following sizes: ⅛ pint, Handy Dope Kit, ½ pint, 1 pint, quart, 1 gallon and 5 gallon cans and 500 lb. drums.

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**W-K-M** DIVISION OF ACF INDUSTRIES INCORPORATED
Dept. BB-12, P. O. Box 2117, Houston Texas

KT 5902 R

## This *Young* REGULATOR controls 3 dampers *over 250 feet away!*

No other regulator matches the performance of No. 700A Young Remote Control Regulator. It gives individual room control of heating or air conditioning by simply turning the knob to the desired position.

Using Young Corner Pulleys this manually controlled regulator operates three Young No. 805 Dampers, size 30" x 18", behind any grilles, over 250 feet away.

See our Catalog in Sweet's Architectural File or Engineers' Product File, or write for copy.

**YOUNG REGULATOR COMPANY**
20910 Miles Ave., Cleveland 28, Ohio

## YOU CAN'T HEAR A CPV SILENT CHECK VALVE CLOSE

Unlike ordinary check valves, there is no hammer and no surge because there is no reverse flow. CPV SILENT CHECK VALVES close instantly and silently as soon as forward flow stops. Why tolerate water hammer when you can eliminate it with CPV Silent Check Valves. Write today for Catalog 600.

CPV

**SILENT CHECK VALVES**
COMBINATION PUMP VALVE COMPANY
851 Preston St., Philadelphia 4, Pa.

*For The Best . . . Specify*

## PHILADELPHIA

MANUFACTURERS INDUSTRIAL THERMOMETERS FOR PIPING, HEATING AND AIR CONDITIONING

More than 55 years of experience go into every instrument we make. This gives you accuracy and dependability when you specify the best—PHILADELPHIA Pipe Line and Duct Thermometers. Let our specialists work with you on your problem in our field.

Since 1905

**Send for Catalog**

**PHILADELPHIA THERMOMETER CO.**
4401 N. Sixth St. • Philadelphia 40, PA.

DAVIDSON
LOW PROFILE
HIGH CAPACITY PC PLEASING CONTOUR MODEL
low velocity roof fan

New and streamlined . . . designed for today's modern flat roof structures . . . as much as 40% lower than conventional types . . . capacities up to 50,000 CFM . . . low velocity . . . vibration isolated . . . ratings conform to Standard Test Code.

**DAVIDSON,** first in the field, has been making a complete line of industrial and commercial roof fans since 1915. For information on the PC or other HYDUTY Davidson fans, write to

Charter Member AMCA

**DAVIDSON FAN CO.**
213 California St., Newton 58, Mass.

**NEW! Waterproof!**

**NOW STANDARD ON ALL REGULARLY CATALOGUED JE SOLENOID VALVES**

New epoxy-clad coils are line-tested at 2300 volts completely submerged in water. Eliminate coil failure! Impervious to almost anything and everything—condensation, fluid spray, frost, oil, gasoline and other corrosive liquids and vapors. Unlimited indoor or outdoor applications. U.L. listed. Wire, write, or phone:

CONTROLS DIVISION **JACKES EVANS MFG. CO.**
4427 GERALDINE AVENUE • ST. LOUIS 15, MO.

# NEW BOOKS & REPORTS...

*Welding Metallurgy Booklet* — A condensed textbook on ferrous and nonferrous welding metallurgy containing 122 pages, 45 illustrations, 25 tables, and 25 diagrams. Material is reprinted from the most recent edition of the AWS Welding Handbook. It covers: temperature changes in welding, structure of metals, mechanical properties of metals, factors affecting weldability, and many other subjects. American Welding Society Information Center, 33 W. 39th St., New York 18. Price, $2.00.

*Proceedings of the National District Heating Association* — An official report of the group's proceedings during its Fiftieth Annual Meeting held in Skytop, Pa., 1959. NDHA, 827 N. Euclid Ave., Pittsburgh 6. Price, $7.50.

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*SB-118 Solar Energy Applications* — A bibliography listing U.S. Government research reports, translations, and other technical documents available to science and industry. Office of Technical Services of the Business and Defense Services Administration, U.S. Department of Commerce, Washington 25, D.C. Price, 10 cents.

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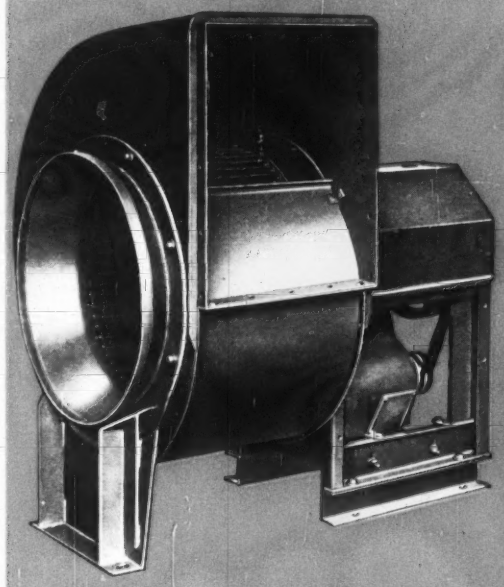

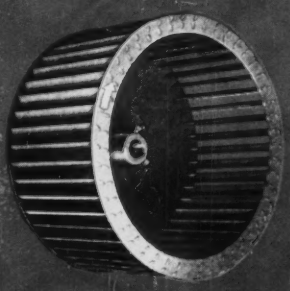

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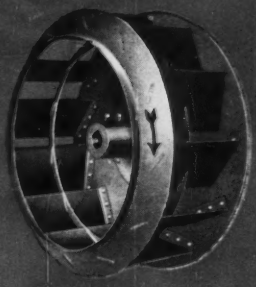

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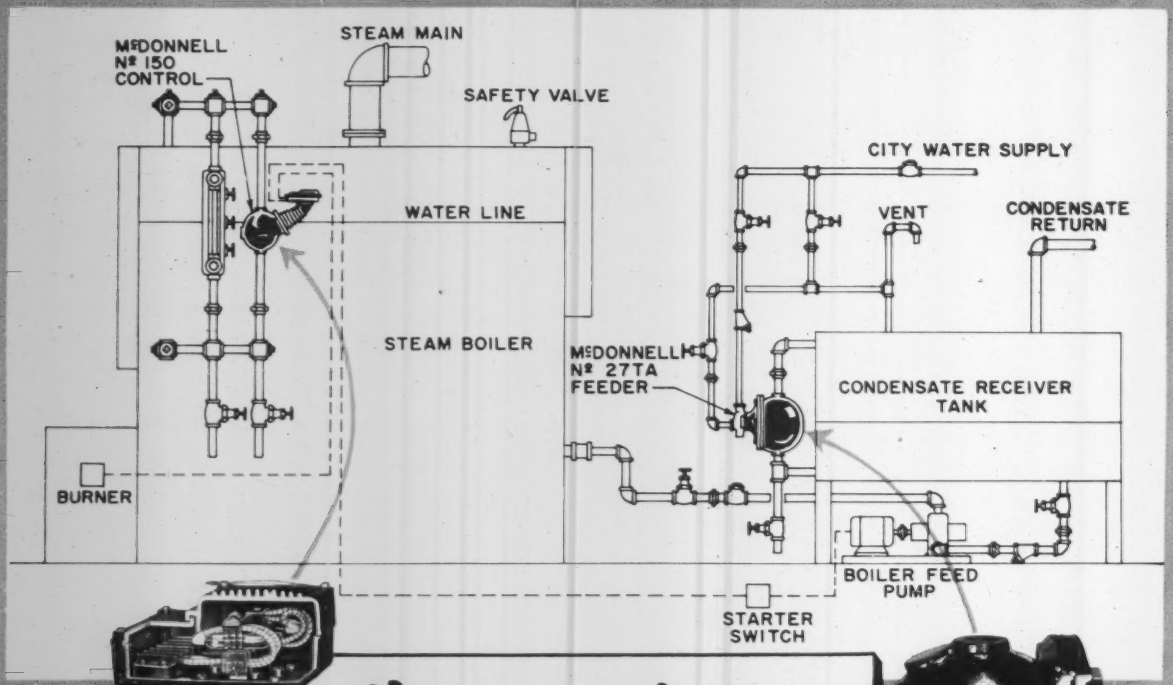


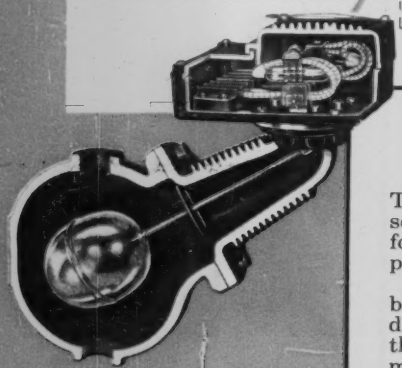

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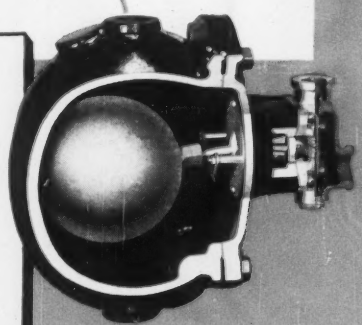

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